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GRAPE CULTURE IN PENNSYLVANIA

By WEBSTER H. SILL, *State College, Pa.*



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PREFACE

Commonwealth of Pennsylvania,
Department of Agriculture,
Harrisburg, Pa., Nov. 25, 1911.

There are few fruits that are more delicious and wholesome than the grape, and when we consider that the period during which grapes grown in Pennsylvania can be depended upon as a part of our daily food supply, covers about one-third of the year, it is remarkable that the cultivation of this valuable fruit is not more general.

A few vines properly cared for will supply the ordinary home with all the grapes needed for family use, and for anyone having, even a small garden, to neglect their cultivation is a great mistake.

This Department published a Bulletin (No. 128) on Grape Culture, in 1904, which was widely distributed and which we have reason to believe was fruitful of good results. But few copies of this Bulletin remain for distribution, and, in order that we may be able to meet the continued demand for literature upon Grape Culture, and at the same time to give inquirers the information resulting from the latest investigations made of the subject, this Bulletin, prepared by one whose education and experience give him special qualification for the work, has been added to the list of our publications.

N. B. CRITCHFIELD,
Secretary of Agriculture.



LETTER OF TRANSMITTAL

State College, Pa., June 14, 1911.

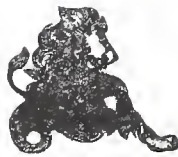
Hon. N. B. Critchfield, Secretary of Agriculture:

Dear Sir: I have the honor of submitting to you the accompanying manuscript to be published as a bulletin of the State Department of Agriculture of Pennsylvania. The aim in preparing this work has been to bring before the farmers and fruit growers of this and surrounding states the experience of a region which has made a success of the grape industry; also to show the actual experience of grape growers and some of their secrets of success as gleaned by the writer. Such a practical and brief treatise on the "Grape Culture in Pennsylvania" the writer believes will be of value. Although this work does not make the pretense of adding a great deal to science, it is intended to furnish the information needed in commercial grape growing.

The writer desires here to express thanks to Prof. R. L. Watts for his aid and helpful suggestions; also to thank the grape growers of the North East region for their interest and co-operation while the field work was being done.

Yours very respectfully,

WEBSTER H. SILL.



GRAPE CULTURE IN PENNSYLVANIA

INTRODUCTION

DESCRIPTION OF THE AREA

The commercial grape vineyard has been developed in North East township, Erie county, Pennsylvania, to the highest state of productivity to be found in any district of the State. It is for this reason that the district was chosen to be the best place to study the grape industry in its commercial proportion.

The study took the nature of a survey of the region, fifty "grape growers," representing the management of 2,000 acres of grapes in bearing, being personally interviewed by the writer. Vineyards were inspected throughout the township and adjoining district and questions embracing the following points were discussed and experience noted; soil types and variations, drainage, whether natural or artificial, soil management, influence of climate, frequency and extent of tillage, fertilizing methods, cover crops, pruning methods, spraying practice, insect and fungus troubles, age of vineyards, varieties, yields of fruit, income per acre, value of land, planting plans, labor problems and machinery. A study was also made of the methods of handling the fruit, including the picking, packing, hauling to the packing house, settling, covering, loading and shipping methods, including iceing and packing of the cars.

The North East region is one of more than passing interest and merits observations as to its general conditions. The topography of the region as shown in Fig. 1 is comparatively level, rising abruptly to the uplands at a distance varying from two to four miles southward from the shore of Lake Erie. Figure 2 shows the extent of the area, something of the methods of planting and training, and the level nature of the country with the lake in the distance. The soils were deposited on the lake floor when it stood at a much higher level than at present, thus leaving long, nearly level plains, bounded by terraces running parallel to the shore line. In a general way it may be said that the gravels and gravel loams are most apt to be found upon the terraces, thus showing that their origin was as gravel beaches. The streams for the most part flow directly across the lake plain nearly northward, and in transition from one terrace to another the stream course is often deeply cut, the bed rock and shales being exposed to a considerable depth.

The surface configuration has proved a determining factor in the developing of the section, for along these shore line ridges or terraces,

the main highways have been placed; and it is beside these thoroughfares that towns, villages, and farmhouses are principally located.

The transportation of the area is of the best. Good roads are to be found over nearly all of the region surveyed. These roads lead into shipping stations located at short intervals along the Nickle Plate and New York Central Railroads; in fact, many of the larger "grape growers," owning farms crossed by the railroads, have sidings of their own. During the season when fruit is being hauled in the region, heavy trains of fruit leave for the great eastern and western markets every morning. The local transportation is well cared for by the Buffalo and Lake Erie Traction Company.

The region of sedimentary soils, or the Dunkirk series in this case, forms an exceedingly rich agricultural section particularly adapted to special crops, though also to general farming. The loams are very well adapted to the growth of the blackcap raspberry. Successful plantations of asparagus have been developed on this type. The lighter gravel loams and sandy loams are better adapted to red raspberries, currants, gooseberries and strawberries. Corn, wheat, oats and hay are the general crops grown upon much of the land, not yet developed to the culture of grapes, tree fruits and small fruits. Truck crops are also important throughout much of the region.

The cultivation of the vine was the highest achievement of ancient husbandry. (x|x Reprint Dept. of Agr. 1904—Some uses of the Grape and its fruit.) The vine and the olive were, in antiquity, the marks and almost the symbols of settled and cultured life. It is interesting to note that grape seeds have been found with the remains of Swiss and Italian lake dwellers, in European groves of the Bronze Age and in the tombs of the Egyptian mummies. (x|x Grapes of N. Y.) According to the botanists, the original habitat of *Vitis Vinifera* or the old world grape is in the region about the Caspian Sea. From here it was carried by the Phoenicians eastward into Asia and westward into Europe and Africa. Grape culture was developed in the Caspian region 1,000 years before Christ.

The old world grape is grown for wine and the American grape for dessert purposes. The difference in the fruit of the vines of the two continents are largely the difference necessary to the two distinct purposes.

The varieties of the *Vitis Vinifera* have a higher sugar and solid content, thus adapting them to the making of wine and raisins. They possess a flavor, which, upon the whole, is more delicate and rich yet less refreshing than *Vitis Labrusca*, the American grape. The American grape was found growing wild in the vicinity of Long Island, New York, in 1697. *Vitis Labrusca*, being the blue variety known as speck (or pork) grapes. Species of *Labrusca* were to be found growing wild in profusion throughout eastern United States.

Lord Delaware seems to have been the original promotor of grape growing in the New World. He imported to Virginia in 1619 a collection of the best French varieties, accompanied by a number of French "vine_dressers." The vines did not succeed under the care of skilled men. The failure was probably due to the ultimate failure of the colony, and hence neglect or more likely from the Phylloxera insect which has since rendered *Vitus Vinifera* growing impossible, commercially, in the East.

In Maryland, if the records are correct, the greatest success was attained by Lord Baltimore, who, in 1662, planted three hundred acres. William Penn encouraged grape growing in Pennsylvania and introduced cuttings from French and Spanish vines. These cuttings were planted in the vicinity of Philadelphia, but seemed not to succeed.

MAGNITUDE OF THE GRAPE INDUSTRY

The production of the grape varies with the different growers at North East, from a few hundred baskets to several thousand eight pound baskets, some growers producing nearly 150,000 8-pound baskets per season. The average yield upon the two thousand acres visited was nine hundred 8-pound baskets in the season of 1909. This season is spoken of as a very good one through this grape belt, and prices did not keep at the top notch. This average was taken from vineyards ranging in size from one acre to one hundred acres. The North East township contains about seven thousand acres of grapes, from which the yield in 1909 would have been in round numbers 6,000,000 8-pound baskets, had all the grapes been packed in this basket. However, this was not the case, as the Grape Products Plant at North East put many tons into the famous "Walker's Grape Juice." The yield from some other vineyards was shipped from the district in twenty-pound trays. Some wine is made in the district, although that industry is not of consequence in comparison with the shipping of table grapes. The improved land in the North East district is held at high figures. For land in grapes of a bearing age, the prices range from \$200.00 to \$600.00 per acre, averaging about \$350.00 to \$500.00, and much land changes hands at these figures yearly.

The production of grape juice is carried on by the North East Grape Products Company, housed in a plant costing \$300,000.00, and capable of using thousands of pounds of the Concord grapes.

The Grape Juice factory is located upon the Lake Shore and Michigan Southern Railway, as shown in Fig. 4. And upon the south side of the factory is placed the "intake" shown in Fig. 5, into which grapes are unloaded from the growers' wagons. Four wagons may unload at the same time under the protecting roof, into hoppers pro-

vided at the side of each wagon. The grapes are then carried upon endless chains over machinery which removes the stems and prepares the grapes for the press room. From the press room the grape juice is run into vats as shown in Fig. 6, where the juice is put through a secret heating process and placed in large glass bottles called carboys and stored. From the carboys the juice is drawn and bottled by the machinery shown in Fig. 7. After bottling, the juice is placed upon trucks and put into a steam pasteurizer as shown in Fig. 8, where it is again heated. The bottles are now ready for the labels, which are put on by machinery, the bottles being packed in cases and carried upon an endless chain as shown in Fig. 9, to the storage room ready for shipment.

The valuable land of this region not only yields excellent crops, but also pays a good interest upon the investment of the growers. The value of these farms range from a few thousand dollars to as high as \$80,000.00 and \$100,000.00. The improvements bear evidence of care and prosperity. The owners cultivate from thirty-five to ninety acres of grapes with a nice margin of profit.

The Chautauqua Grape Belt, of which the North East district is a part, is one of the most famous of any along the Lake Erie Valley. Thousands of acres of grapes are cultivated along the lake both east and west. Westfield, Brocton, Portland, Dunkirk and such points are important grape-shipping centers. Westward, Sandusky, Ohio and Benton Harbor, Michigan, are important grape shipping points.

Not only do we consume thousands of baskets of grapes in this country, but we have a growing foreign trade which will be more thoroughly developed as our grape acreage increases. The American grapes meet very successfully the competition of the European grapes in the markets of this country. It is distinct enough in flavor and purpose to find a place with the best of *Vinifera* grapes.

The development of the commercial vineyard has been very rapid. The first vineyard on record as being planted in the North East district was planted in 1861. Not until 1887 did grape culture assume anything like commercial proportions. In 1891 the majority of the vineyards were set and setting has since been going on by spurts and starts according to the market variations of the grape crop. About 1904 the grape industry received a check from the ravages of the black rot, which at that time threatened the extinction of the industry. Prompt interest and action on the part of the growers brought about a thorough investigation by the several Experiment Stations and the United States Department of Agriculture, which resulted in the complete control of the infection. Scarcely has any been seen for the past two years. With this victory over a disease of such threatening character the commercial grape industry was

given a new lease of life and has since reached a high standard of excellence. The good prices received for grapes in 1907 and 1910 were not without their influence. Today we may travel for miles with scarcely a break in the well cultivated, sprayed and cared for vineyards.

HISTORY OF THE GRAPE

When colonization of America began the explorers returning to the Old Country carried glowing descriptions back with them of the bountiful yields of grapes to be found in the New World. These reports came from all parts of the North American continent, for the wild grape was found in almost every part. These sights suggested the vineyards of England and Europe with which the explorers were familiar. They thought of bringing their varieties of grapes to the colonies with them. Not once did they think of there being anything of value in the native American grapes. Not until the beginning of the eighteenth century did the colonies learn that the European grape could not be successfully grown in Eastern United States. Indeed it was not until the beginning of the nineteenth century that the native grapes of North America began to be cultivated. For decades previous to this date people had been content to gather the wild grapes which grew freely in the virgin forests. At the beginning of the nineteenth century, literature of the grape began to appear, and some of the best species were chosen and cultivated in private gardens. Bolling, in his sketch of Vine Culture, published in 1765, was probably the first man to suggest the hybridization of the American and European vines. He thought by so doing it would be possible to obtain new varieties which would be better adapted to our soils and climates. The first real test of native grape under cultivation (x|x Grapes of New York) was made near York, Pennsylvania, where, in 1818, Mr. Thomas Eichelberger set out four acres of the native vines and successfully demonstrated the possibility of cultivation of native grapes. By 1826 the acreage near the borough of York had reached one hundred and fifty acres of vineyard, the Alexander, the York Lisbon, and the York Claret were the native grapes largely planted. Later, the Catawba and Isabella varieties were grown in York and Lancaster counties, Pennsylvania. Roinesque gives an account of acreage in America in 1825 as six hundred acres, in 1830 it had increased to five thousand acres, or ten-fold in five years. After 1830 we may consider viticulture a firmly established industry in the United States.

The first variety of native grapes to become generally distributed and cultivated, was an offshoot of the Alexander and *Vitis Labrusca*, which probably had its origin before the Revolutionary War, upon the banks of the Schuylkill in Pennsylvania, hence, one of the synonyms, the Schuylkill Muscadell. It was sometimes known as the Cape and as Tosker. Two other varieties of the *Labrusca* type de-

serving mention, are the Isabella and the Catawba. The former is a native of South Carolina, and the latter is of uncertain origin. The Catawba is still cultivated as an important variety in several of the great grape regions.

While the northern varieties came from the *Labrusca* type, the cultivated grapes of the South came from the *Vitis Rotundifolia*, or what was known in the South as the Scuppernongs or bullet grapes.

Two varieties noted for wine making were becoming established at the same time with the *Labrusca* and the *Rotundifolia* types. *Vitis riparia* was the northern species, and its variety under cultivation was the Clinton, which is still grown as a successful variety. *Vitis aestivalis*, a species grown in the South and represented by the Norton, is now commonly grown.

Previous to the middle of the nineteenth century, grapes were grown mainly or entirely for the production of wine. Americans have never taken well to the use of wines, hence the industry had not the needed incentive to growth. But at this time a marked change came about. A demand began to arise for table grapes. Transportation, in the stage of rapid development at this time, began to distribute the fruit in fresh state to be eaten upon the tables of people in all parts of the country. Many grape regions became important at this time, the history of which it is not the purpose of this paper to follow.

The advent of the Concord, states Prof. U. P. Hedrick, in the "Grapes of New York," was a landmark in American grape growing. It was first exhibited in 1852 by E. W. Bull as a seedling and recorded by the Massachusetts Horticultural Society as the Concord. It is also stated in the same connection that the qualities that have made the Concord so important in commercial grape growing are: Adaptability to a varying sets of cultural conditions; fair shipping qualities; hardiness; productiveness and comparative immunity to fungi and insects. From it have come a considerable number of our best American varieties as the Worden, Moore Early, Pocklington, Martha and Cottage, all pure bred seedlings and many crosses.

In 1845 a cross was made between the Black Hamburg and Isabella, from the seed of the Black Hamburg fertilized by pollen from Isabella a seedling was produced which bore fruit in 1850. In 1851, Downing wrote, "there can be no doubt that this is the first genuine cross between the foreign grapes and our natives." The variety was given the name of Ada by its originator. The variety, however, is known as Allen's Hybrid. In much the same way the Roger's Hybrid originated a few years later. It is hoped that this brief outline of the development of grape varieties and the industry may lead to a somewhat clearer understanding of the development of our varieties to the busy reader. More exhaustive works should be referred to for the full accounts,

CHOICE OF LOCATION

SOILS

Soil Types: The soils of North East township are of glacial lake influence. Their mode of derivation and formation has produced an extremely variable condition. Some of these soils have been laid down in very deep water, some in shallow water, while still other types and phases have been influenced by swift currents and wave action. The underlying rocks and shales of the region do not influence the soil to any extent. The depth of the soil varies from a few inches to many feet, its texture and structure varying throughout, oftentimes in the same farm or even in the same field.

Drainage, one of the prime requisites of successful grape growing, is, in most places, naturally good. The underlying rocks and shales are at such extreme depths as to give ample chance for subterranean drainage through the subsoil. These subsoils are composed, in most cases, of a large percentage of gravel throughout the township. The soils vary from light to coarse, and many have an admixture of small boulders.

The soils of the area surveyed range from the fine sand to the heavy clay types; the loams, gravel loams, clays and such medium to heavy types predominating. The Dunkirk loams and gravel loams are the soils most used for the production of grapes. These soils are dark to light brown in color, rather silty, and from seven to twelve inches in depth. Silt and sand are present in varying amounts, forming, on the average, a mellow, easily cultivated soil.

The subsoil is variable in texture and is made up of lenticular strata of clay or clay loam, silt and sandy material, giving it the average texture of a loam. The relation of these is not uniform, but it is usual to find under the soil a heavy stratum of clay loam which gives way to silty or sandy material, and this, in the bottom of a three foot section, to another band of heavy material. Then, strata of coarse sand and gravel may sometimes be encountered, but these are not common. Sometimes the clay band may form the surface and give way to lighter material in the upper subsoil. The characteristic section is one of great variability in texture from point to point; but no class of material is very extensive either in area of distribution or thickness.

In addition, there is generally present a considerable amount of gravel and stone consisting of a predominance of sandstone and shale

with many rocks of igneous origin in great variety, which are generally smooth and rounded by water action. The amount of stone is not constant, and on a few areas is so abundant as to hinder cultural operations. The color of the subsoil is also variable, but is generally brownish. The different stratas of material may vary in color. The brown and bluish subsoils are those mostly encountered.

The gravel loam is a soil of yellowish to brown color, ten to twelve inches in depth, and composed of materials varying in texture from silty gravels to coarse gravels. The rounded gravel and pebbles are found in abundance near the Buffalo road, especially east of the Borough of North East, and along the region traversed by the Cemetery road. Southward, along the foot of the escarpment, the gravels are again important. These soils for the most part are the best soils for grape production, probably because of their excellent drainage and aeration. They are also easily tilled because of their open nature. In the early spring these gravel soils warm up quickly and ripen their crops somewhat earlier than the clays. Many gravel loams need humus or vegetable matter which may be easily incorporated by the use of such cover crops as winter vetch, mammoth clover, crimson clover, and many other crops which are now being used by the best growers. These crops are sown and plowed down at least once in three years. This humus will add life to the soil and increase its capacity for holding and furnishing plant food to the plant during growth.

The subsoils encountered in these gravelly loams are variable. Many of them are very porous, being composed of alternate strata of gravel and clay, and in some cases, sandy material. They allow the soil water, and air to circulate freely, while holding it at a depth at which the grape root feeders easily attain through a loose soil. Passing southward along the Cemetery road toward the escarpment, heavier soil types are encountered on the more level areas, ranging into the gravels again at the foot of the rise to the upland. These clay loams and heavy soils, while requiring drainage in most instances, produce a grape of excellent quality, both as to flavor and keeping qualities.

The Dunkirk clay loam varies from a dark brown to a grayish colored loam eight to ten inches deep, beneath which is a heavy clay loam usually grading into a stiff, impervious clay. The upper part of the subsoil is usually brown tinged with red, but with increasing depth it becomes a dull brown, sometimes mottled with drab or yellow. These soil areas are level or gently undulating. Their origin is lacustrine, as are the other soils of the Dunkirk series. The difference in origin being that the clays and clay loams are deposited in quiet water and the gravels in moving water. The clay loams rank very high in the production of grapes when tile drained.

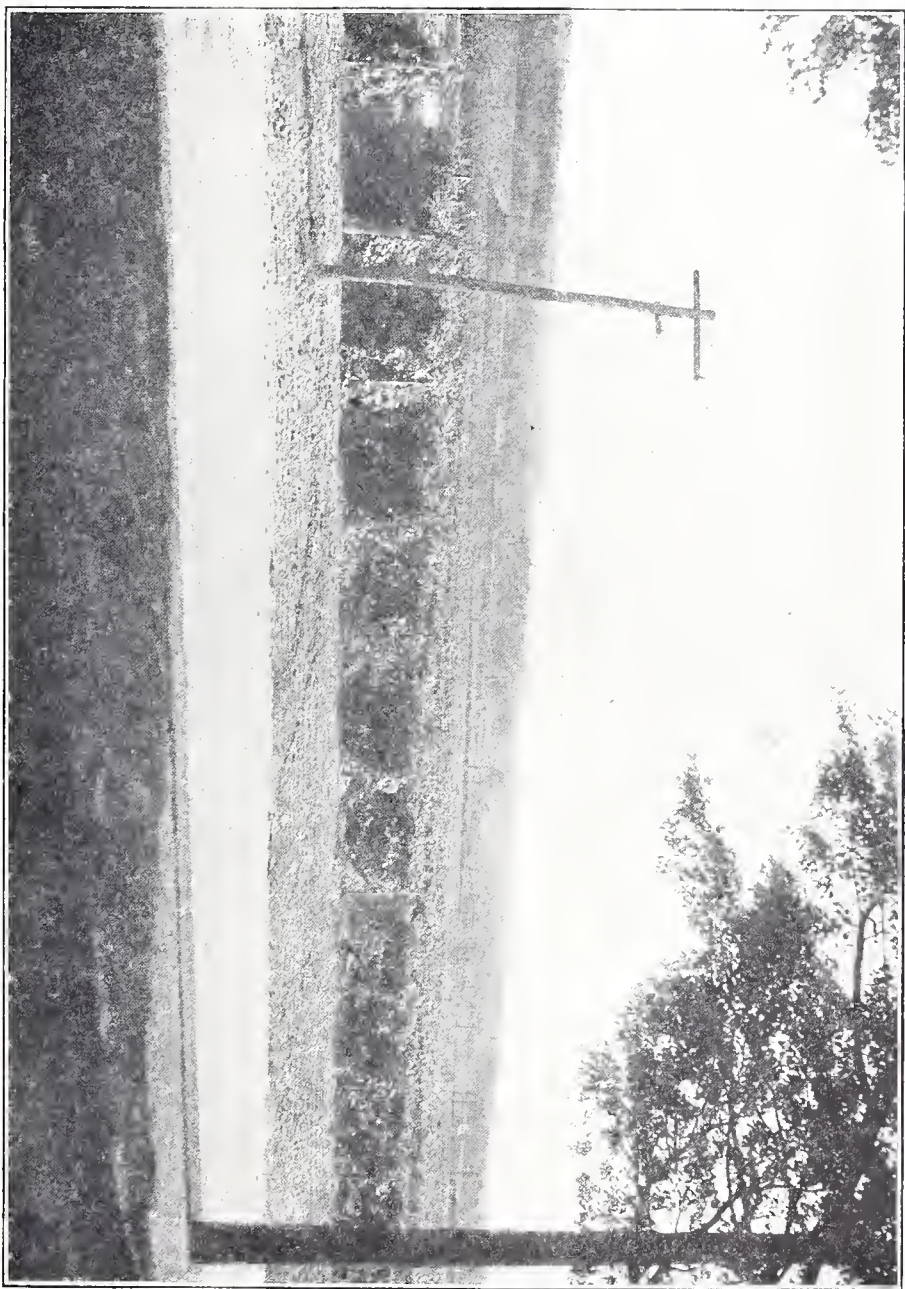


Fig. 1. A vineyard view looking toward the escarpment.



Fig. 2. A vineyard view looking out upon Lake Erie.



Fig. 3. A model vineyard.

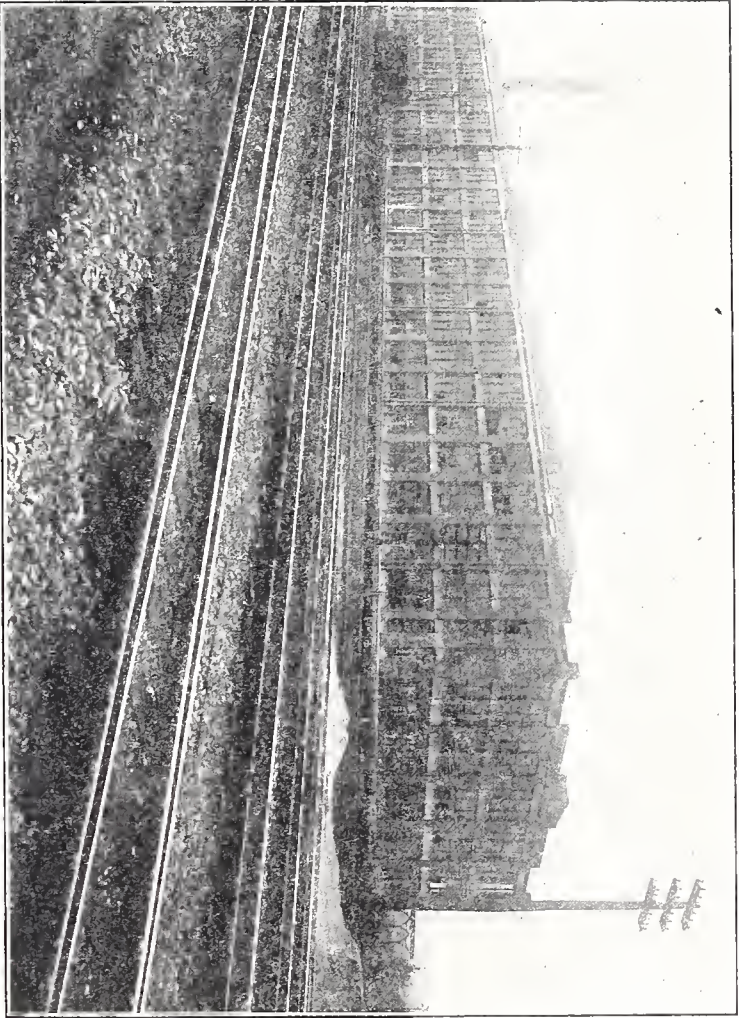


Fig. 4. The Grape Products Plant.



Fig. 5. Where the grapes are unloaded at the Grape Products Plant.

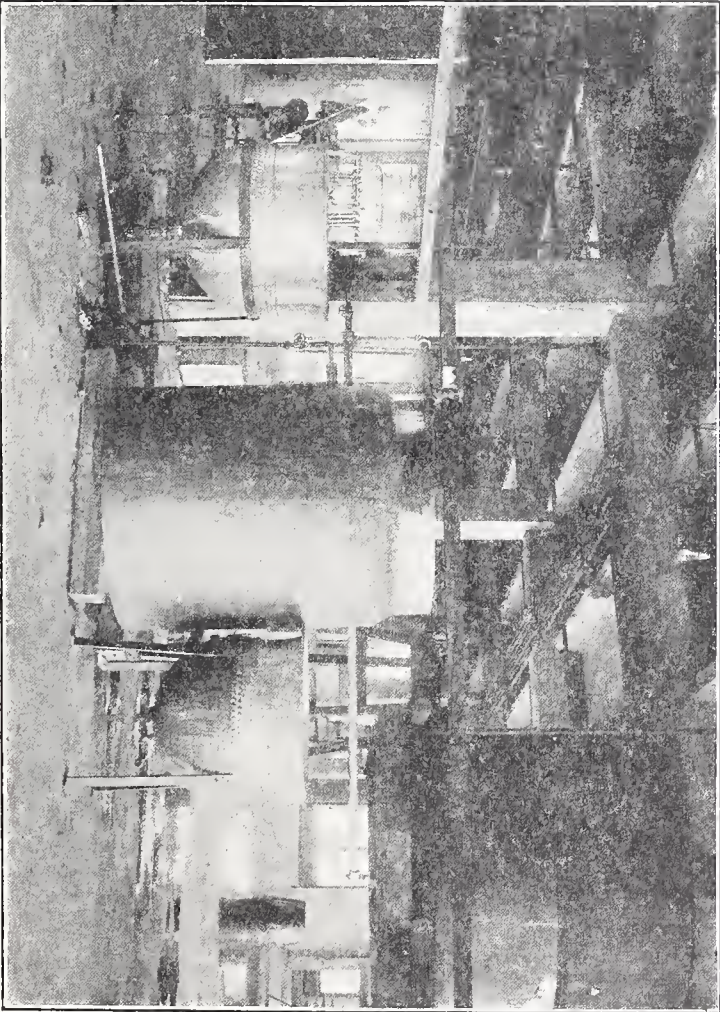


Fig. 6. Storage tanks.

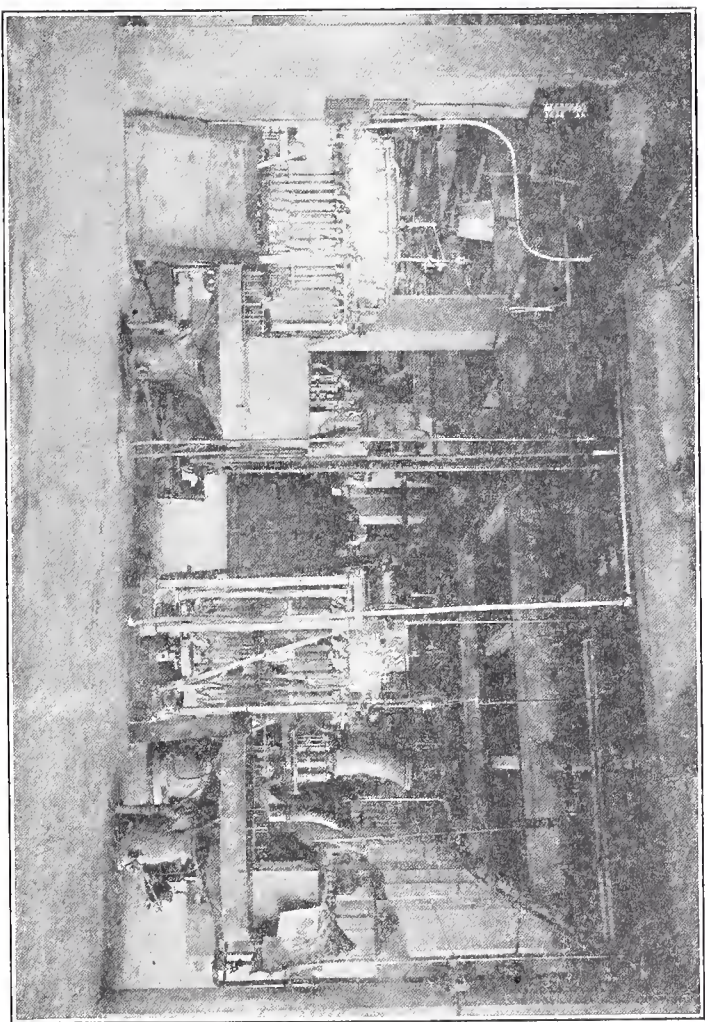


Fig. 7. The bottling machinery.

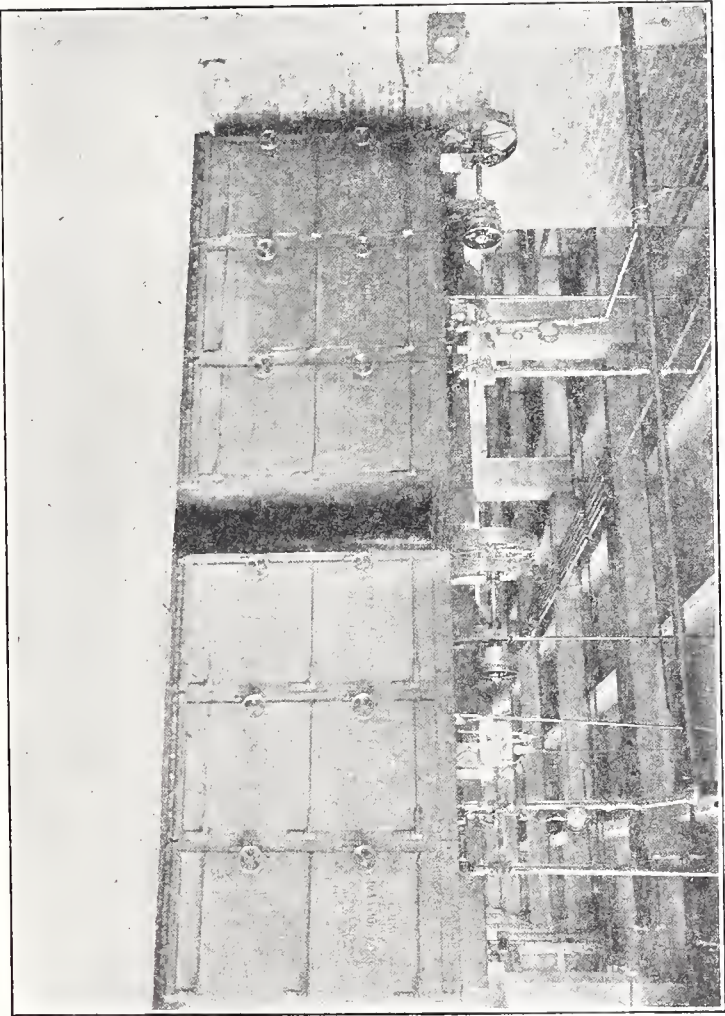


Fig. 8. Pasteurizer for steaming the bottled grape juice.

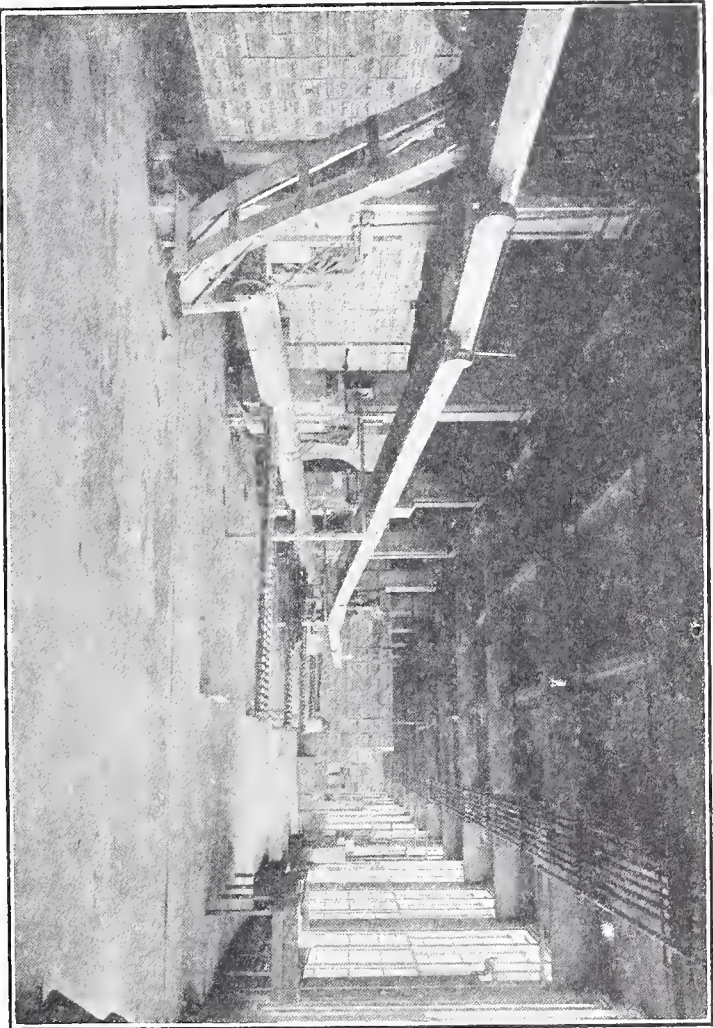


Fig. 9. Endless chain for handling cases of grape juice.



Fig. 10. Peaches and prunes used as a companion crop for grapes.

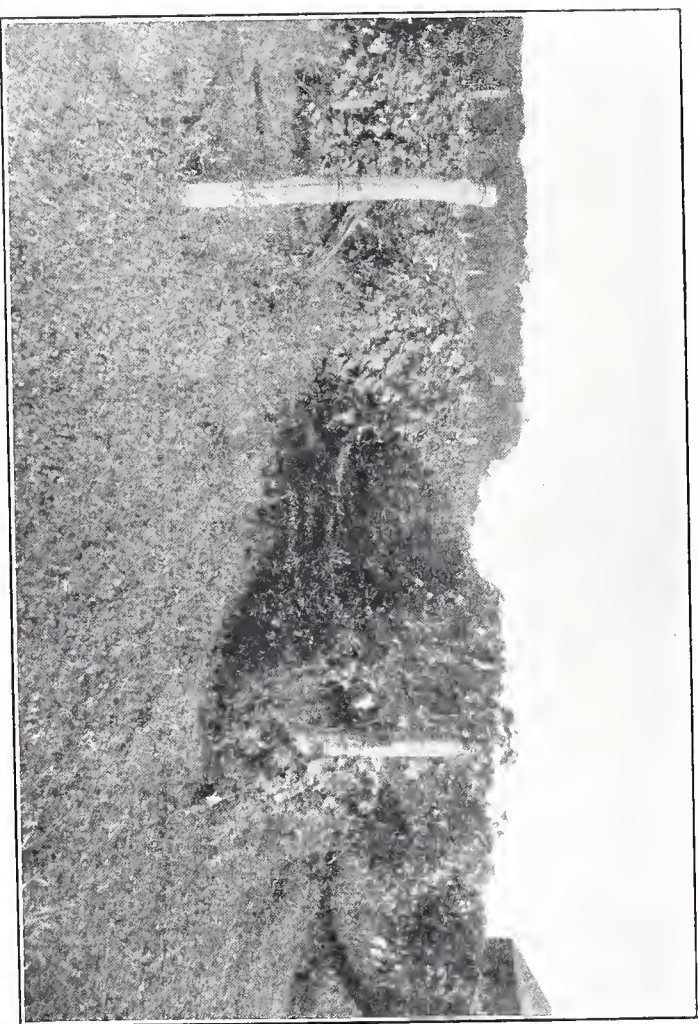


Fig. 11. A neglected vineyard.

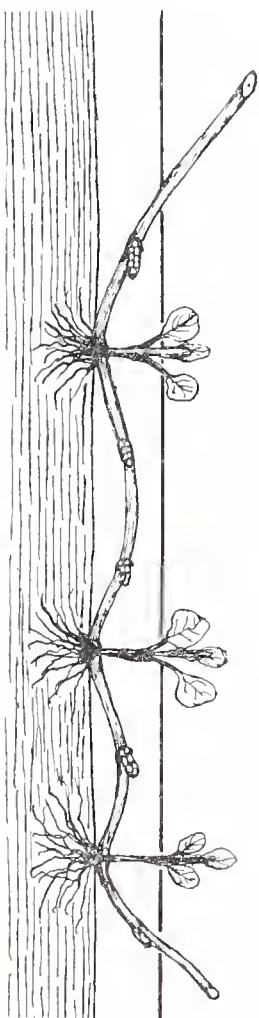


Fig. 12. Spring Layering.

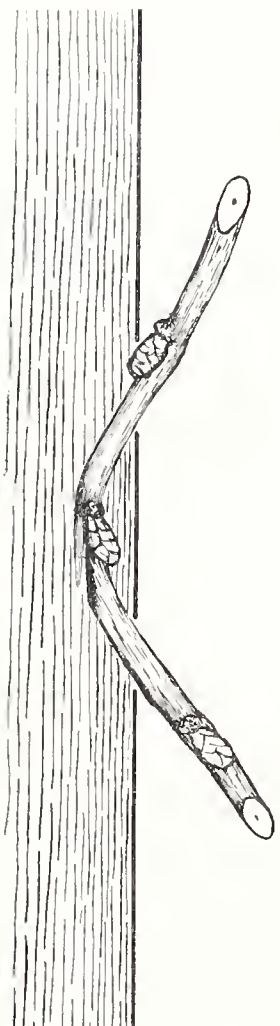


Fig. 13. Fall Layering.

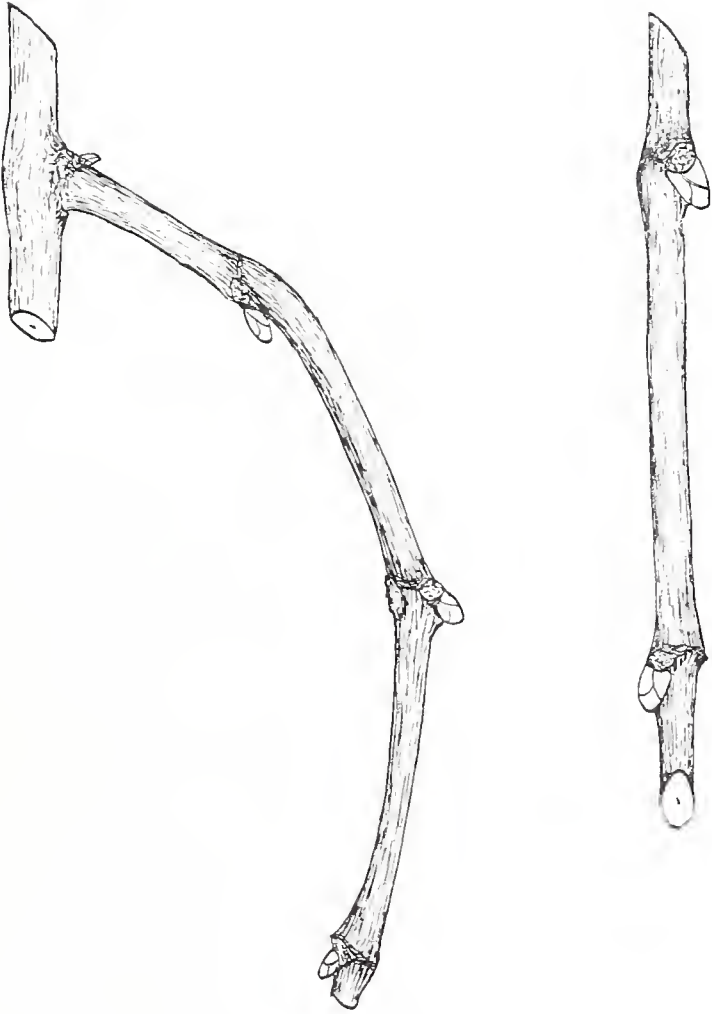


Fig. 14. Cuttings.



Fig. 15. A two year old vineyard on the W. S. Wheeler farm.

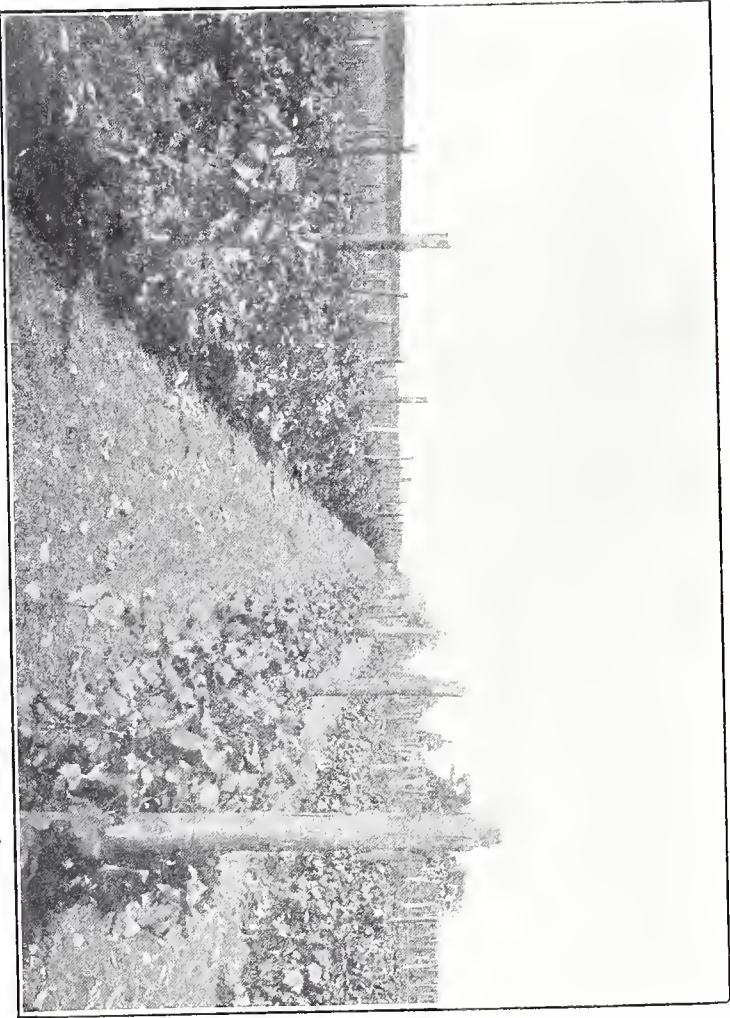


Fig. 16. A four year old vineyard on the W. S. Wheeler farm.

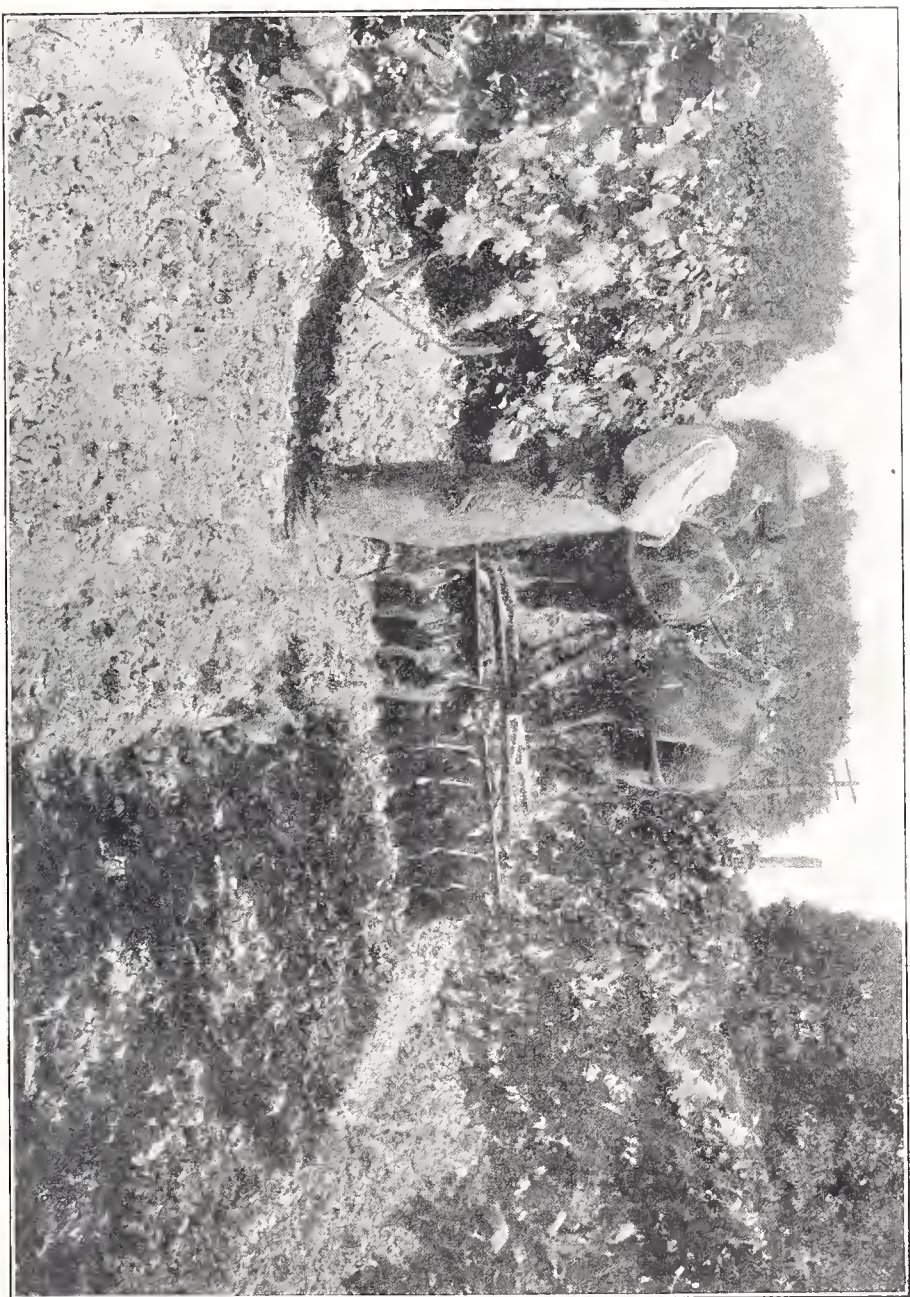


Fig. 17. The Disc harrow at work in a North East vineyard.

Natural Fertility: This is one of the important factors in the choice of location. Some growers contend that they are able to grow successful crops of grapes year after year without the addition of any fertilizer. It may be said that such men are very seldom met with, and although the fertilization of the commercial grape vineyard is not yet reduced to anything like a science, yet the best growers are adding yearly to the fertility of their grape lands by the use of animal manures, commercial fertilizers, and vegetable matter in the form of cover crops. The latter men regard fertilization of their vineyards not only necessary but a paying investment.

Drainage: The district is drained by several short streams running northward through deep-cut ravines and gorges into Lake Erie. These streams cut through the lacustrine deposits of the region and often quite deeply into the underlying shale and rocks. Drainage, either natural or artificial, is carried into these avenues. The Lake plains, while being comparatively level, give sufficient slope in most places for successful drainage. Below the terraces, which occur at frequent intervals from the present shore line southward to the uplands, are seepage areas. This gives rise to swampy conditions unless artificial drainage is resorted to.

The Dunkirk loam, which is the prevailing type found in the area surveyed, is naturally well drained. Even in very nearly level locations the loose condition of the subsoil allows for very nearly perfect drainage. This is not usually the case upon the heavier soil types found in the North East township. The clays and clay loams need artificial drainage. Their surface drainage is poor and their subsoils are nearly impervious to the passing of water. Drainage water often stands upon the surface of the soil, preventing cultivation and leaving the soil in a sour and baked condition. Nor is this all of the injury resulting, but the vines are prevented from making proper growth. The fruit does not develop properly and the foliage wears a sickly yellow color. It can easily be seen that the mechanical condition of this soil is one of the limiting factors in grape production under these conditions. Air cannot enter such a soil to help in the liberation of plant food and in the development and growth of beneficial bacteria.

Open ditches are sometimes used to carry surplus water from the surface and prevent its standing until evil results follow. This method is too expensive to be used generally, in that it is a constant source of annoyance and takes up valuable space on the land. The initial expense of laying the tile drain is greater than the opening of temporary ditches, but when properly laid, it is permanent. Tile should always be carefully laid with special regard to the slope of the land and uniformity of the soil. Space will not permit a discus-

sion of this subject here. As a general rule, permanency should be the aim of every drainage project.

Yields and Quality: Grapes are influenced more than is sometimes supposed by the texture of the soil in which they are grown. To this fact many of the best growers in the North East district will testify. The gravel loams generally yield the larger crops of fruit, although it is somewhat inferior in flavor when compared with fruit of clay soils. The flavor of the grape grown upon clay types is almost invariably sweeter and more juicy. The results of some growers upon the clay soils would lead one to believe that by proper attention to the mechanical condition of the soil, together with proper feeding and care of the vine, as high yields may be produced as on the lighter series, together with the superior flavor and keeping qualities of the heavier types.

CLIMATE

Influence of Water: That large bodies of water have an influence upon the climate of a region has long been noticed by fruit-growers. The fact is now made use of by the North East district in a commercial way. Vineyards are protected from early and late frost for four or five miles inland from Lake Erie, as will be seen by reference to the tables of temperature and precipitation. The wood of the grape vine needs to be hardened off in the fall sufficiently to stand the extreme cold of the winter. The water temperature of Lake Erie is from five to ten degrees warmer in winter and cooler in summer than that of the adjacent land. The ameliorating effect of this warmer water during the winter, while influencing the temperature to some extent, rises to its maximum of value during the early spring in April and May and during the early fall in September and October. At these times a killing frost may mean failure to the entire grape crop. The reader should notice that the real value of these ameliorating influences is to be found in the protection afforded bearing vineyards from early frost during the months of April and May. Not less important is the delay of frosts during the months when the crop is ripening and being harvested. This tempering influence hardens the young vines and bud growth and thus insures immunity from winter injury.

Rivers and smaller lakes may also furnish the climatic environment necessary for successful grape culture. Many such locations may be found in the State of Pennsylvania, especially upon well drained flats or plains adjacent to our larger rivers where grape culture may be very successfully followed. The prospective planter should note carefully the conditions of the soil, drainage and climate which the writer has attempted to bring out by the use of the North East district as the concrete example of nearly ideal conditions.

Elevation: Frosts are also influenced by elevation. It may be noticed that late frosts do much more damage in the lower lands without the tempering effects of bodies of water, than upon an elevation. The French grew their vineyards upon terraces on the sides of the hills. Here immunity from unseasonable frosts was in a measure obtained. The early planter, coming to America, of course, used the same methods as in the old country and planted upon terraces. However, it was soon found that planting in this way was unnecessary and the practice was discontinued.

Influence of Climate Upon Injury by Insects and Fungus Diseases: It has been unquestionably proven that temperature and humidity of the atmosphere bears a relation to insect and fungus troubles. The summer of 1910 brought more injury from the Grape Leaf Hopper (*Typhocya comes*) in North East district than it has before for many years. This was probably due in large part to climatic conditions. Many insects are influenced in this way. To learn the effects of climate upon insect life is to be prepared with control measures before great injury has been done. This subject will be treated more fully under the heading of grape insects.

Every grape grower has noticed that there is a relationship between fungus development and climatic conditions. Spraying will control the growth of fungus; yet close observation of the weather conditions may suggest the necessity of an additional application of a fungicide, thereby saving the crop at a critical time. The climatic factors affecting the growth and spread of fungus diseases on plants are four in number: (1) water, (2) light, (3) temperature, (4) wind. Of these four the first and third are most important. The vineyards at North East during the summer of 1910 were comparatively free from both black rot and mildew fungus. This was due in part to the spraying done in the region. But even vineyards that were not sprayed seemed unusually free from fungus troubles. Climate not only affects the growth of fungus, but also the production and germination of the fungus spores. The climatic factors may again act to cause more susceptibility in the host plant for the fungal development. Moisture is especially important for spore production, it being necessary for some fungus growths to have moisture in order to produce spores and germinate them. It is stated by grape growers, that black rot is not only abundant in humid weather, but more abundant on vines having a vigorous sappy growth. It is noticeable that mildew injury is closely related to climatic conditions. Thus, by watching weather conditions, we may protect a vineyard from as great injury as otherwise would occur.

Length of Season at North East: By the length of season, will be meant the time from the last killing frost in the spring to the first killing frost in the fall. The average length of the grape season at

North East is 199 days. If we compare this with the length of the season 75 miles south at Greenville we will find that the average there is 148 days. This makes a difference of 51 days, or nearly two months in favor of the lake shore region. With this additional length of season, grapes as well as other fruits are fully matured. The length of the seasons is shown by the following table:

DATES OF FIRST AND LAST KILLING FROSTS

Year.	Erie.		Saegerstown.		Greenville.	
	Last in spring.	First in fall.	Last in spring.	First in fall.	Last in spring.	First in fall.
1901, -----	4/10	11/19	5/15	10/4		
1902, -----	4/8	11/8	5/29	10/8		
1903, -----	4/5	11/11	4/28	9/29	5/8	9/29
1904, -----	4/21	9/22	5/12	9/22	5/12	9/21
1905, -----	4/22	10/26	5/24	10/26	5/21	10/26
1906, -----	4/8	11/1	5/10	10/1	5/11	10/11
1907, -----	4/20	10/19	5/22	10/9	5/21	10/21
1908, -----	4/17	11/13	5/5	9/30	5/4	9/30
Average, -----	4/14	10/30	5/14	10/5	5/13	10/8

This difference of 51 days gives the length of season required to produce maximum crops. Although this gives ideal conditions, it is not absolutely necessary to grape production. However, a man, in choosing a location for a grape plantation on a commercial scale, should bear in mind this great difference in length of season and locate accordingly.

The mean temperature for a year, it will be noted by the following table, is not influenced to a very great extent by the lake.

Month.	Erie.		Saegerstown.		Greenville.	
	Temperature.	Precipitation.	Temperature.	Precipitation.	Temperature.	Precipitation.
January, -----	26.2	3.03	25.0	3.11	27.1	3.65
February, -----	26.2	2.85	22.9	3.36	25.5	2.54
March, -----	33.5	2.66	34.8	3.36	36.6	3.97
April, -----	44.4	2.40	45.3	2.86	45.6	2.90
May, -----	56.6	3.43	57.3	4.65	57.5	3.34
June, -----	66.5	3.75	65.6	4.34	66.6	4.31
July, -----	71.3	3.21	69.4	4.97	70.3	5.00
August, -----	69.6	3.26	67.3	4.48	67.2	3.69
September, -----	63.9	3.49	61.8	3.85	61.7	3.48
October, -----	52.9	3.80	50.5	2.98	49.3	3.42
November, -----	41.1	3.61	38.7	3.54	38.3	2.99
December, -----	31.9	3.06	28.5	3.32	31.0	2.72
Year, -----	48.7	38.55	47.3	44.82	48.00	42.01

It will also be noticed that the mean temperature for Saegerstown, a few miles over the escarpment is only 1.4 degrees colder on the average than at North East. If we take the mean of the months of December, January and February only to compare with the mean of the same months at Saegerstown, a difference of 2.64 degrees is shown. This shows that the midwinter temperature is influenced materially by the lake.

Availability of Markets: The final factor to be considered in the choice of location is the access the vineyard will have to market by some of the many means of transportation. The first point to be considered is whether the local or wholesale market is the one to be catered to. This, of course, will be decided by the nearness or remoteness of a good local market, and means of transportation available, and also by the quality of the fruit. If the fruit is to be sold at retail the market should be easily accessible by wagon or trolley.

The local market is not sufficient for the handling of even a small portion of the North East district fruit. Some of the fruit is carried from North East to Erie and Buffalo by trolley direct to the retailer, but the bulk is taken by the wholesale market. These wholesale markets reach from the Atlantic seaboard to San Francisco. Cars are loaded at North East for Pittsburg, Chicago, St. Louis, San Francisco and other points in the West, as well as for New York, Philadelphia and Buffalo in the East. However, the bulk of the wholesale trade from this region goes to the West. The Pennsylvania Road from Erie gives a good outlet to Pittsburg and Philadelphia. The Nickle Plate and New York Central carry the most of the western

trade. These roads run fast trains for fruit and perishables, bringing the fruit into market in good condition. Such transportation facilities are as valuable as unusual, and add much to the value of the region.

PRODUCTION

STARTING THE COMMERCIAL VINEYARD

Propagation: A commercial grape grower in most cases will desire to buy grape roots from a reliable nurseryman; but some growers believe that more vines should be home grown. If vines are propagated in the home vineyard, selection of cuttings may be made from the higher yielding and most disease resistant plants. The reason usually given for purchasing plants or vines is, that a good nurseryman can produce plants cheaper than the vineyardist.

A vacancy in a vineyard is most easily filled in certain cases by layering from an adjacent vine, providing the vine is strong enough to stand the strain. This operation may be performed in early spring or late fall.

Spring Layering: Vines should be set on purpose to give wood for this method for layering, as it will seriously interfere with fruitage if practiced in the bearing vineyard. In early spring the vines are bent down into a small trench two to three inches deep, where they are secured at the nodes by small pegs driven into the ground. Roots are emitted from the buds in contact with the soil. This is illustrated in Fig. 12. New shoots are sent up and several plants are obtained from one vine by this method of layering. Sphagnum moss may be filled in about the layered vine to conserve moisture until the shoots obtain a start. When the growth of the new shoot has reached a height of six to eight inches, the moss should be removed and loose soil should be filled into the trench about the base of this new growth. As this succulent growth reaches eight to ten inches in height, it should be staked and tied. On the following spring the old vines are cut between the new shoots and transplanted with the ball of roots produced.

Fall Layering: If the layering operation is carried on in the fall with the young succulent growth of the season, more care should be taken that the stems do not decay but strike root readily. The best practice is to cut a tongue in one side of the layered cane one or two inches in length and one-third the thickness of the cane as

shown in Fig. 13. Roots are then emitted at this point freely and better plants are secured than where no cut is made. Usually only one or two buds are covered on a vine.

Serpentine Layering: For one reason or another it may be desirable to use the serpentine method, differing from the former by not having the continuous trench. This method is most often used in propagating vines growing in sod or on the home grounds. By this method the vine is bent down to the ground where it is secured by a peg or a stone placed upon the vine and the vine covered with soil to the depth of two or three inches. One or two buds are covered in this method. In case vine wood is rare the vine may be bent down in several places and secured in the same way. Rarely is this method the most successful or most practicable, but it may be used where spring layering has been neglected. Plants are easily secured if care is taken that the vines are not disturbed and that the layering is done at the proper time. Cut the vine between the node where two buds are covered, two plants will then be gotten.

Seed: The seed of the grape does not reproduce true to type when planted. It is therefore used only for the propagation of new varieties in experimental work, but not for the production of plants to be used in a commercial vineyard. Of the different varieties coming from grape seed, about one in one hundred is worth saving for further testing, hence it does not interest us in this connection.

Cuttings: The method of propagation most used and most highly successful is by cuttings. Cuttings may be made in several different ways and at different seasons of the year. For commercial propagation of grape roots the cuttings should be taken in the fall as soon as the leaves drop or at least in the winter before the first of April. The wood pruned from the vines during the winter is commonly used in making cuttings. If this practice is followed the cuttings must be removed at the time the pruning is done and not after the severed vines have been subjected to weather conditions.

Cuttings of two general types are made: (First) cuttings containing one, two or three buds; (second) cuttings containing one, two or three buds plus some of the parent stem as in the mallet cutting illustrated in Fig. 14, or a cutting severed at a point of attachment to the parent branch, in which case a small portion of the heel of the branch is allowed to remain on it. The ideal cutting should bear two or three strong buds and be about six inches long. The cutting with two buds, shown in Fig. 14, is to be preferred provided the proper length of internodes may be found. The mallet cutting is also a good one, but where large numbers of cuttings are to be made it is not practical, because only one cutting can be made from a cane. The single eye cutting is most used when the stalk is scarce and the largest number of roots possible are desired.

The cuttings may be made with a pair of sharp pruning shears, cutting just beyond the terminal buds of the cutting leaving two or three buds according to the length of the internodes. The knife may also be used in this process, but the shears, if handled carefully, will be found more expeditious. In case single eye cuttings are made the cuts should be about one inch from the bud on either side. If the mallet cutting is made the parent stem should be cut so as to leave a length of one inch, the cane bearing the buds springing from the center of this parent cane as illustrated. Two or three buds are left as upon the bud cuttings. This in general shows the best ways of making cuttings for propagation.

Hard wood cuttings should be dormant for a while to allow the callous to form over the cut ends before it is set under field conditions. Cuttings taken during the fall and early winter should be tied in bundles of fifty to one hundred and stored in sand, sawdust or sphagnum moss in the cellar at a temperature of 30 to 40 degrees Fahr. If carefully packed and watched most varieties will strike root readily when set in the spring but a few of them, of which the Delaware is an example, do not root so easily. Cuttings of such varieties are sometimes buried in the fall in ground upon which the sun shines directly upon the surface. These cuttings are placed in the ground, inverted so that the butt ends are just under the surface. This will promote a good development of callous by the greater heat upon the butts. Upon the approach of cold weather they are covered with a heavy mulch of soil or are transferred to the cellar.

Another practice in rooting tender varieties, is the use of the cold-frame for starting the cuttings. They are then left in the frame for a year before being planted out in the field or in the nursery row. The single eye cutting may be started in pots placed in the cold-frame and covered by glass. They may also be started in the open propagating bed of the greenhouse. The cuttings are placed in the bench about one inch deep with the bud up. After the plants reach several inches in height they are transplanted to the nursery row and grown as the other cuttings.

Grafting: Grape vines are also propagated by grafting for various reasons. Among these reasons may be mentioned: First, the changing of worthless varieties quickly to varieties producing marketable grapes; second, the grafting of varieties which are susceptible to various diseases upon grape roots of varieties known to be resistant to disease; third, new varieties may be more quickly tested by being grafted upon a well developed root system than by being propagated in the usual way. Grafting of grapes fills a distinct niche in the management of the grape vineyard.

Cleft Graft: This graft is made by cutting the old vine squarely off two or three inches below the surface of the ground, using a sharp

saw. The surface of this cut may be smoothed off with a knife and the root split by the same implements used in cleft grafting the apple. The scions are cut to two or three buds and sliced to a thin wedge shape. Two scions are now inserted in contact with the cambium layer upon each side of the cleft, while the latter is held open with the grafting knife. As soon as the knife is removed the cleft draws together and holds the scion in place. Care should be taken that the cambium layer, that is, the growing parts, in both stock and scion, are made to coincide. The union is now covered with loose soil to the level of the ground and the graft is complete.

Tongue Graft: This graft is one deserving perhaps only passing mention for Pennsylvania conditions. It is made in much the same way that the whip and tongue of the apple is made, except that the tongue is made some distance from the end of the scion instead of at the end. As in the former graft described it is made below the surface of the ground. The stock and scion should be nearly of the same size. The stock to be grafted is first cut on the slant beneath the ground and split to allow the entrance of the tongue of the scion. The union after being made should be securely tied and filled around with soil as in the former method.

Preparation of Soil: Numbers of grape growers at North East when asked how to prepare the soil for a vineyard state that the preparation is much the same as for corn. By this they mean that it should be done thoroughly. The soil should be deeply stirred and pulverized to give free access of the grape roots to all parts of the soil section. The root system, although not running deeply, requires a great deal of moisture at the depth of two or three feet. This moisture should be so held as to leave the soil open and loamy. By this it is meant that the air should be able to circulate at quite a depth, yet the soil should not dry out quickly.

The incorporation of humus will give this loose, areated texture, and at the same time hold sufficient moisture for the needs of the grape plant in a drought. Humus may be gotten in the soil in three ways: First, by applying stable manure; second, by plowing down cover crops, and third, by a combination of the two methods. This humus should be thoroughly mixed with the soil previous to the setting of the vineyard. It will then give the fluffy or spongy texture to the soil, which is so much desired. Cultivation rapidly burns the humus out of the soil, hence we see the importance of having a good quantity at the starting of the vineyard to produce a vigorous growth of root and vine. Very rich soil is not necessary, but soil of good medium fertility and proper tilth should be gotten.

All objects which will in any way interfere with future cultivation should be removed before planting. Plowing should be moderately deep and pulverization should reach the bottom of the furrow if

possible. The soil should have an optimum of moisture content. The disc harrow will do a valuable service in this place, also the lighter harrows such as the acme, spring-tooth, plank drag or Meeker smoothing-harrow.

This thorough pulverization is important in order that the roots may spread through the entire surface of the soil, which they will do in a properly prepared seed-bed, even when the vines are planted eight by nine feet. When the proper condition of moisture and texture is reached the vines may be set.

Setting the Vineyard: The proper time for setting the vineyard under Pennsylvania conditions is in the early spring. By "early spring" is meant the earliest possible time in the spring when the conditions of temperature and moisture are right. April is the month in which vines should be set if at all possible. If it is not possible at this time, it should be done in May. The grower will have less chance of success the later he waits in the spring before setting. Plenty of rains occur in starting the vineyard at the time mentioned. Plants make an early start and are out of the way of drought in the latter part of the summer. Larger and better developed vines are thus obtained, which will go through the severe winters of the Pennsylvania climate.

The universal distance of planting in the North East district is eight by nine feet, that is vines eight feet apart in the rows and rows nine feet apart. This gives ample room between the vines to handle a team in plowing with a three-gang plow, harrowing, horse-hoeing, or hauling the grapes out in the fall. The vines set eight feet apart in the row produce ample wood to put up four or five canes and take up the whole of the trellis. Some of the best growers contend that these distances are not as good as seven by nine, where more vines to the acre are used and less wood to the vine would be required to produce a maximum crop of fruit. It cannot be said with certainty which is the proper distance to plant.

One year old plants from cuttings are most often chosen for setting if vigorous enough. In case one year old vines are weak and not large enough to come rapidly when transplanted they should be grown another year. Yearling vines of vigorous growth are preferable.

Only healthy vines should be accepted from a nurseryman at any price, and if vines are home grown all diseased or weak ones should be discarded. Vines are usually received as they have been taken up from the nursery bed. In this case all roots should be cut back to one foot with a sharp knife. Cut back also all injured roots with a clean smooth cut removing all but two or three basal buds of the vine, and cutting immediately above the bud. Vines should not be allowed to stand before planting. If it is necessary to keep the roots

for some time they should be "heeled in" by digging a trench in a well drained place. Lay the vines in the trench, slanting them from the perpendicular with the tops above the ground and the soil mixed among the roots. When properly done this practice will keep the vines two or three weeks until they may be set permanently.

In the region surveyed, the vines are planted in deep double furrows opened by a common plow to facilitate working the vines later. This places the root growth deeply in the soil. A quantity of good soil is drawn around the roots of the vine and tramped well to hold them in place until the soil is thrown up either by the plow or the disc harrow. The vines once set should be thoroughly cultivated until the first August, at which time the cultivation should be stopped and the cover crops sown. Vineyards are sometimes intercropped the first season. In such an event it is best to produce a crop which will be taken off the ground early in the season or which will be harvested without materially stirring the soil. Vines cultivated late are apt not to stop growth in time to ripen their wood sufficiently to stand the oncoming winter. Ordinarily the vines are set every eight feet in the furrows, which are opened every nine feet. This requires about six hundred vines per acre, costing twelve to eighteen dollars per thousand, from Fredonia, N. Y., or about seven to ten dollars per acre. When \$1.50, the cost of setting is added, the total cost will be \$8.50 to \$10.50 per acre.

Yields of Young Vineyards: During the first two years nothing is thought of except the growth of vine and the development of the root. If interplanting is practiced at all, it should not be allowed in the vineyard after the first year. In the fall of the first year the vines are sprawling over the ground. During the winter they should be cut back to from two to four buds, from which the season's growth is to come. All but two shoots should be rubbed off as soon as they get a fair start, leaving only the stronger shoots to continue the growth.

In the spring of the third season the trellis is put up and the vines tied to the first wire. The vine or cane should be one-half inch in diameter when tied up. If this size is not produced in two years the vines should again be cut back to three or four buds and allowed to produce a new and stronger cane. Some vines may need the addition of a small amount of nitrogenous fertilizer. It is better to allow no fruit to be borne the third year, thus allowing all strength of the vine to go into the making of stronger and more vigorous wood. Many successful fruit growers observe this method. An exception to this rule might be cited in a vineyard which seems to be making a too rapid growth. The bearing of fruit will check this rapid growth.

During the fourth year the vine should bear six hundred eight pound baskets of excellent fruit, in most cases larger and better than

that upon the older vineyards. By the fifth year the yields should reach eight hundred eight pound baskets, remaining at that point as a minimum, and rising to one thousand to twelve hundred eight pound baskets, in certain seasons. One vineyard of small size was reported as producing twenty-two hundred eight pound baskets of fruit. This is an unusual yield and was followed by a weakened condition in the vineyard. The vines must produce sufficient wood each season to be put up for the following year, as well as producing their yield of fruit. Hence, we see the importance of maintaining a balance between wood growth and fruit production.

Varieties: The varieties grown in the North East district are not great in number, the Concord making up a very large percentage of all the grapes grown. This is so much the case that many growers have no other variety aside from the Concord in their plantings. Indeed it is not overstating conditions to say that ninety per cent. of all grapes grown are Concord. This variety is known to almost all people who are at all familiar with grapes or their culture, as it is the dominant type of our native *Labrusca* grapes. It gives us also many of our cross breeds of grapes. Perhaps its greatest meritorious character is its adaptability to all manner of soils and environments. In the Chautauqua Grape Belt, of which North East region is a part, it is grown upon every type of soil, from a heavy clay to a coarse gravel, with equally as good success, at least in so far as a yield is concerned. However, the flavor of the Concord is improved upon the clay soils. It is grown with varying success in every grape growing region in the United States.

In addition to its adaptability to varying soil and climate conditions, it has a high degree of fruitfulness. It outclasses all the other varieties in the annual cropping tendency. It is described by Prof. U. P. Hedrick as having "added to the above points of superiority in hardiness; ability to withstand the ravages of both disease and insects; comparative earliness and therefore certainty of maturity in the Northern regions; fair size of bunch and berry; good color, and an abundance of blooms, making a most handsome grape." The Concord leaves out and blossoms somewhat late in the spring and does not therefore often suffer from spring frosts, and the fruit is not easily injured by late frosts and hangs well upon the vine. The same authority goes on to say that the Concord grape is not without faults, as its quality is not high and it lacks in sugar content to such an extent that much sugar must be added to make a good wine. It does not keep or ship as well as grapes having *Vinifera* blood. The Concord is not very resistant to phylloxera, being subject to it more in warm dry soils of the South. The fruit ripens about mid season and keeps for one or two months. The clusters are rather large,

single or doubled shouldered, and broadly tapering. The berries are medium large and roundish, slightly black with an abundant blue bloom. Two to three clusters are borne upon each vigorous shoot.

Niagara: This variety holds the place among the white grapes that the Concord holds among the black grapes. The variety has had a run of popularity occasioned by extensive advertising. The variety was at first advertised to be better than it was, which fact brought about a reaction at the time the vines began to bear. Until recently it has been almost impossible to get a fair estimate of the variety from the growers. The yields from this variety compare very favorably with the Concord. In hardiness the Niagara is somewhat lacking, being more easily injured by very cold weather in the Northern regions.

The berries of the Niagara are larger than the Concord, as are the bunches, making a handsome fruit. The great disadvantage of the Niagara has been its great susceptibility to black rot and other fungal diseases. This fact has caused the Niagara to be thrown out of the vineyards of the South.

The variety, according to Hedrick, was originated at Lockport, Niagara county, New York, by C. L. Hoag and B. W. Clark. It was introduced as a cross between the Concord and Cassidy, by the Niagara Grape Co., about 1882. Since black rot has been controlled by spraying it becomes possible to grow this variety profitably with good conditions for growth.

Delaware: This variety fills the unique place of being the first American grape in flavor. It is next to the Concord as a commercial variety, being grown very successfully both North and South. It is fast becoming a valuable grape in the South as an early grape to ship North. It is one of the very hardiest varieties and withstands great extremes of climate. It is more resistant than other varieties to fungus diseases and insect troubles. Its greatest disadvantage is its slowness of growth and the small size of the berries. It is a very productive variety with the tendency to overbear, it being sometimes necessary to thin the fruit. The high quality of the fruit makes the variety especially valuable and brings upon the market double the price of Concord. It is an excellent table grape, having a beautiful coloring of the skin and fine flavor. It is sought after by winemakers of the Delaware wine and for making blends. The variety does best in a deep rich well drained soil. It merits the best cultivation and careful spraying. It should be closely pruned to prevent overbearing and small wood growth.

The history of the origin of the Delaware is contested. The variety was first brought to notice by Abram Thompson, editor of the Delaware Gazette, of Delaware, Ohio. The variety was first brought into the town from the farms of Mr. Warford and Mr. Heath, where it

was known locally as the Heath or Powell variety. It is generally conceded to be a hybrid of *Labrusca Bourquiniana* and *Vinifera*. The variety ripens a few days in advance of the Concord.

Moore's Early: This grape is best described as an early Concord. All the fruit of this variety is usually marketed before the Concord season begins. The vine makes a vigorous growth, but requires careful tillage and thorough spraying. It succeeds best upon an open well drained soil which has a good supply of humus and plenty of plant food. The clusters have a tendency toward looseness and are not as large as the Concord clusters. As is usual with *Labrusca* grapes the berries crack quite badly and rattle from the vine easily. It is not an ideal variety for this reason, but is the best for Pennsylvania conditions until a better early variety is introduced.

Moore's early is said to have been originated from the seed of the Concord by Capt. J. B. Boore of Concord, Mass. It was first exhibited in 1871 before the Massachusetts Horticultural Society.

Worden: As an offspring of the Concord, this variety possesses most of the good qualities of the Concord and lacks some of its bad ones. It is very much prized for garden plantings, because its flavor is better than the Concord and because of the large size of the berries. The pulp is softer than that of the Concord, but the fruit does not keep as well when shipped. Like the Concord, the berries crack badly and do not recover as well as the Concord. It makes an excellent variety when harvested promptly when ripe.

The Worden was originated from Concord seeds planted in 1863 by Schuyler Worden, Oswego county, New York. It was named by J. A. Place of Oswego, N. Y., and listed by the Pomological Society in 1881.

Catawba: This variety is one of the four leading varieties grown in Eastern United States. Nearly one hundred years, the length of time it has been grown in the United States, has not lessened the popularity of the variety. It is now grown very largely in the Central Lakes regions of New York, where it is used in making champagne and light colored wines. Its high quality and attractive appearance makes it the valuable red grape that it is. The vine is very vigorous, adapting itself readily to different climatic conditions. It has been supplanted in the Chautauqua Grape Belt because of its late ripening. It is also quite susceptible to mildew and other fungus troubles. Its excellent keeping qualities are a strong point in favor of the Catawba, often being kept until early spring.

Catawba was introduced by John Adlum, of the District of Columbia, about 1823 (x|x Grapes of N. Y.) Adlum procured the variety from Maryland in 1819, but the true parentage of the variety has never been satisfactorily settled. It is generally supposed to be a cross between *Vitis Vinifera* and *Vitis Labrusca*.

Agawam: Another red variety of *Labrusca* and *Vinifera* parentage which has gained much popularity. It is the most popular of the named varieties of the Roger's hybrids. It has a large berry and cluster and a sweet aromatic flavor, and an attractive appearance. It is an excellent variety to keep, often being stored until January. It seems to prefer a rather heavy soil and profits by a thorough cultivation. Like the other hybrids, containing some *Vitis Vinifera* blood and is susceptible to fungus troubles. These are easily controlled, however, by careful spraying.

Brighton: This grape is the first secondary hybrid to be produced and has proven the secondary hybrid to be superior in vigor to the primary hybrids. It was produced by crossing *Diana Hamburg* and *Concord*. The former being a cross between *Vitis Vinifera* and *Vitis Labrusca*, while the latter is a pure breed of *Labrusca*. This variety is one of the most valuable of the grapes of this class. *Champion* comes close to the *Brighton* in the same class. This variety, but for two defects, would take a more prominent place in viticulture than it does. The fruit deteriorates very rapidly after ripening, thereby making it a variety which will not bear long shipment well. The other defect is its self sterility, which is more marked than in most other varieties now grown. The fruit clusters are large and the berries are medium to large, and are a dark glossy red color, good quality and fine flavor.

The *Brighton* was originated as a hybrid, as before stated, at *Brighton, N. Y.*, by *Jacob Moore*, a careful breeder. The fruit was first gathered in 1870 and exhibited at the meeting of the *New York Horticultural Society* in 1872.

Campbell Early: This variety is one of the latter varieties being introduced in 1892. As a variety it is not as cosmopolitan as the *Concord* as to soils, it being a shy bearer when not adapted to the location where grown. It at first enjoyed great popularity, but it has not met all expectations of it as a commercial grape. This is no doubt due in no small degree to the lack of attention on the part of growers who are willing to grow mediocre types of productive qualities rather than to learn the special needs of such an excellent variety as the *Campbell Early*. The variety is nearly a fortnight earlier than the *Concord*, the clusters are larger as are also the berries, than the *Concord*. It is sometimes placed upon the market in an unripe condition, due to its early coloring habit, which has been a detriment to the variety.

The variety was originated by *G. W. Campbell*, of *Delaware, Ohio*, from a seedling of *Moore's Early* pollinated by another seedling produced by the same breeder. The latter parent was a seedling of *Belvidere*, pollinated by *Muscat Hamburg*.

Champion: This variety is still grown quite largely because of its great vigor of vine, its productiveness and its fine appearance. In quality it is poor and will be replaced by better varieties as the grape trade learns better its poor points. It grows best upon a sandy soil. It was first grown about 1870 in New York. It is of *Labrusca* type. The fruit ripens sometime before the Concord, ships well during a rather short season. The clusters of the berries are medium to small. Berries are medium to above, and are of a black color and covered by a blue bloom.

CULTIVATION

Purpose: The commercial vineyard is almost universally cultivated to conserve the moisture which is so vital to its productivity. A dust mulch should be kept upon the vineyard at all times during the middle of the summer. Weeds should be kept down to prevent the vines from being robbed of moisture and plant food.

The vineyard is plowed at varying times from May first to May fifteenth with a three furrow gang plow throwing the furrow away from the vines, toward the center of the space between the rows. The six furrows break up very well all the soil in the interrow. Harrowing usually follows with Clark's cutaway, the disc, or spring-tooth harrow, until some time during June, usually about the middle. Horsehoeing now takes place, working the soil away from the base of the vines to a depth of about three inches. The process is delayed until this date to increase the possibility of exposing the grape root worm, which is at this time in its pupa stage. This insect will be treated more fully in its relation to the grape later in this report. The horse hoe will remove nearly all of the soil around the roots of the vine, leaving the larvae of the grape root worm exposed to the weather. Very little hand hoeing is required if the horse hoe has been used skilfully.

Cultivation should take place after every heavy rain from May first to August tenth, breaking up the forming crust and conserving the moisture which otherwise would be rapidly lost through the compacted soil. The dates given cannot be religiously adhered to for the reason that the seasons vary so much that no date can be definitely set which will apply to every season. Nevertheless cultivation should take place every week or ten days throughout the season.

The work of plowing a vineyard needs but little explanation. The gang plow is run rather shallow and throws the soil away from the vine. It pulverizes the soil very effectually between the rows, but leaves a ridge of soil a foot or more wide standing up along the line of the vines.

Following the plow the disc cutaway or spring-tooth harrow is run through several times. The horse hoe which follow at its proper



Fig. 18. The Anderson grape hoe used at North East.



Fig. 19. The Peabody cultivator much used to break compact soil.





Fig. 20. A well cultivated vineyard with a young mammoth clover cover crop.

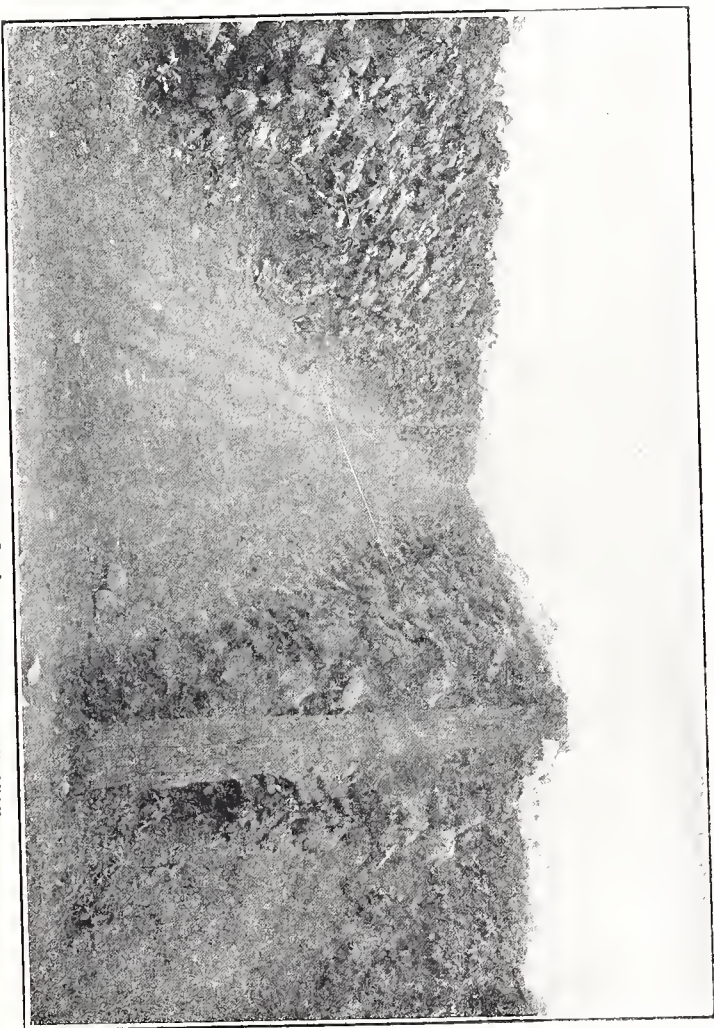


Fig. 21. Winter vetch and clover as a cover crop.

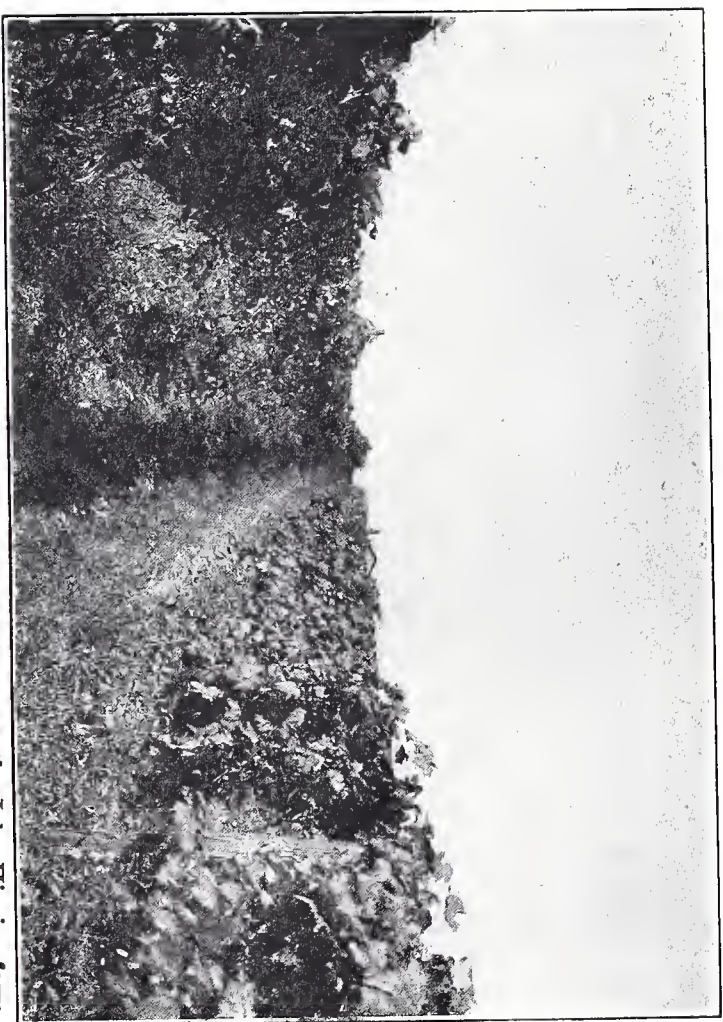


Fig. 22. An excellent cover crop of winter vetch and oats on the John Higgins farm.

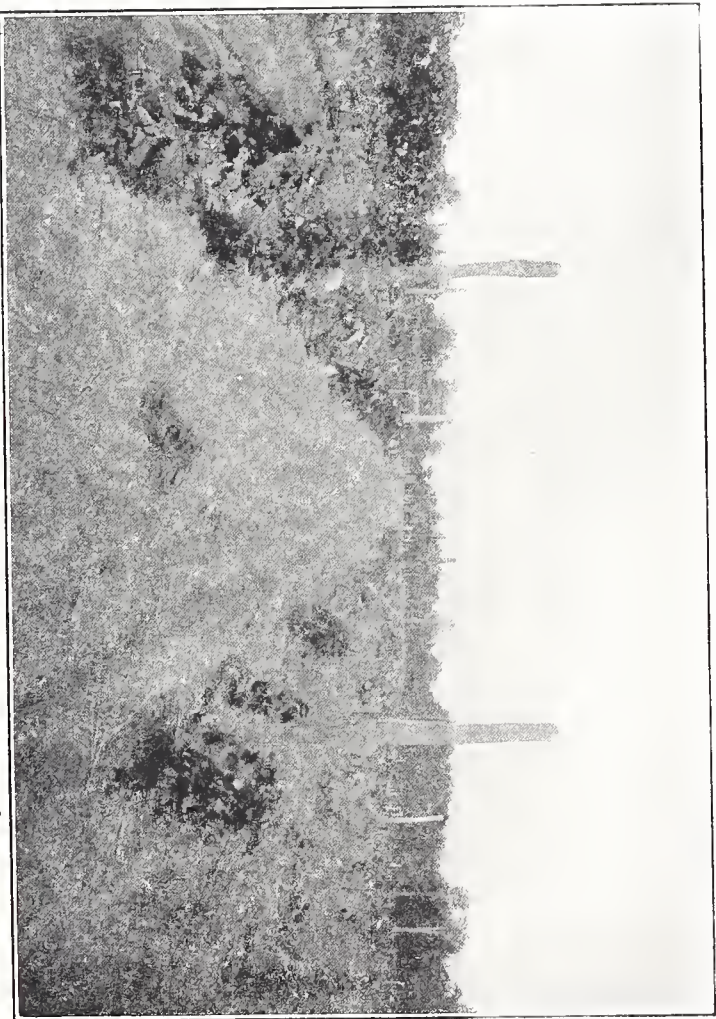


Fig. 23. A cover crop of oats on the W. S. Wheeler farm.



Fig. 24. Fruit as it is borne on the Umbrella Kniffin system.



Fig. 25. The same system after the fruit has been removed.

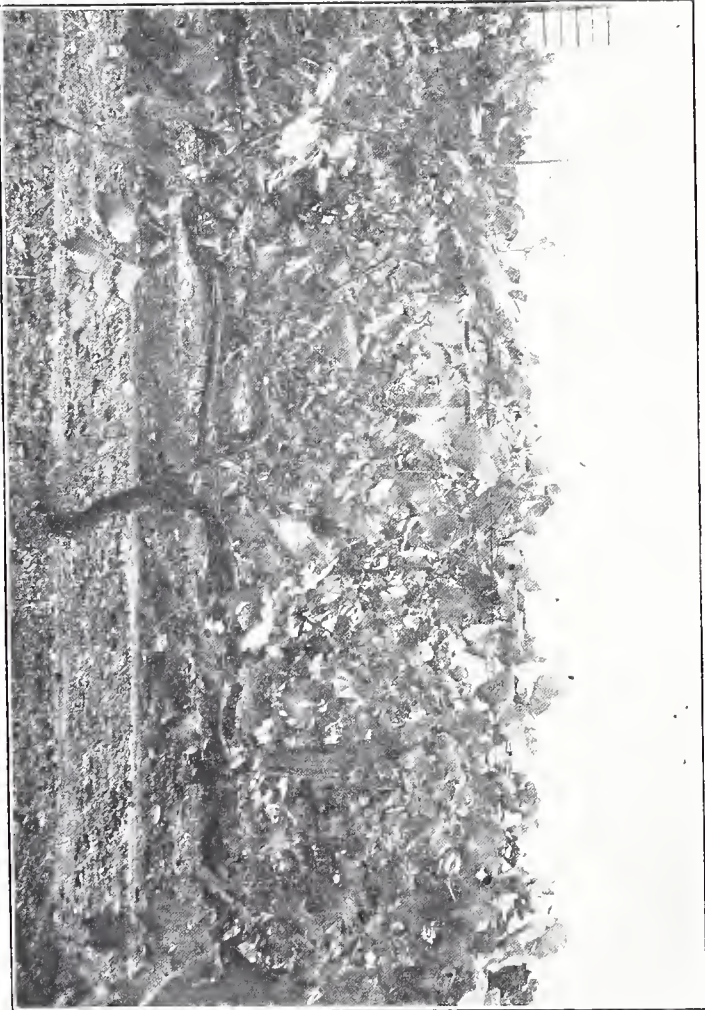


Fig. 26. The Chautaugua system of training.

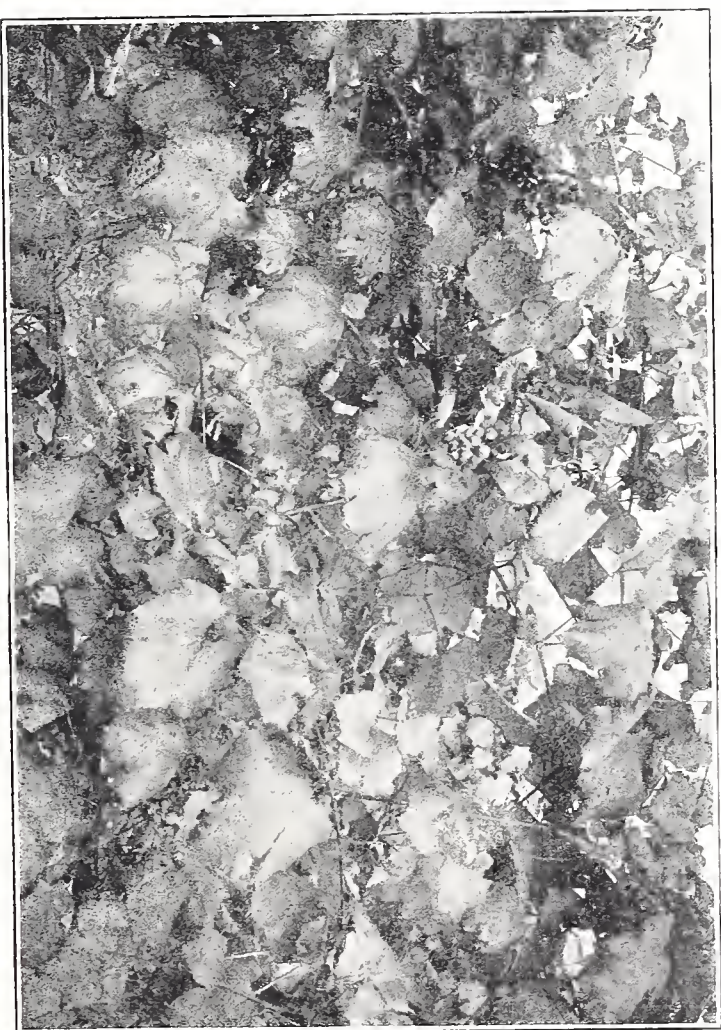


Fig. 27. The foliage is well distributed by the Chautauqua system.

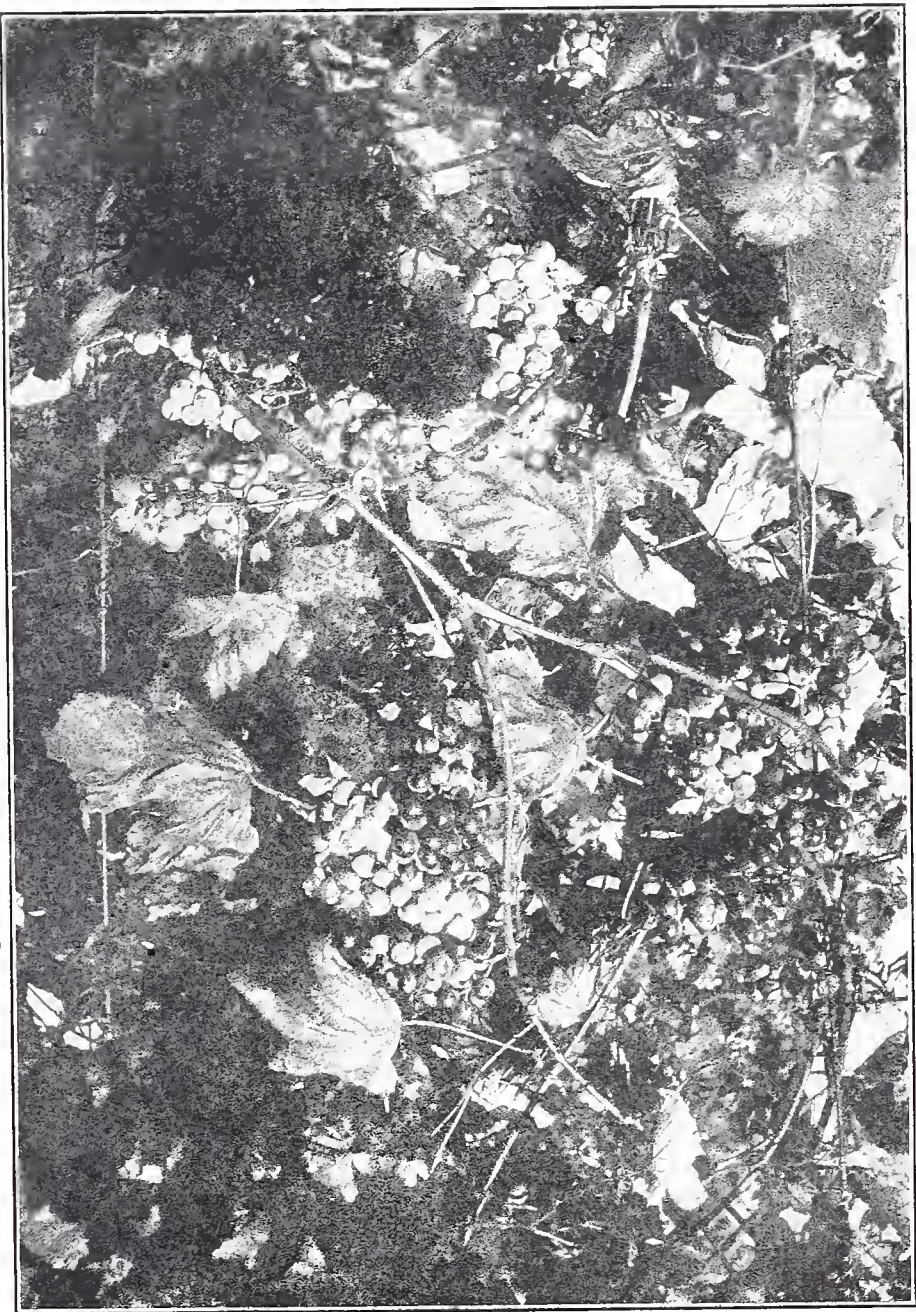


Fig. 28. Fruit as borne upon the Chautauqua improved system.



Fig. 29. An excellent yield of luscious fruit.



Fig. 30. The Chautauqua improved system of training.

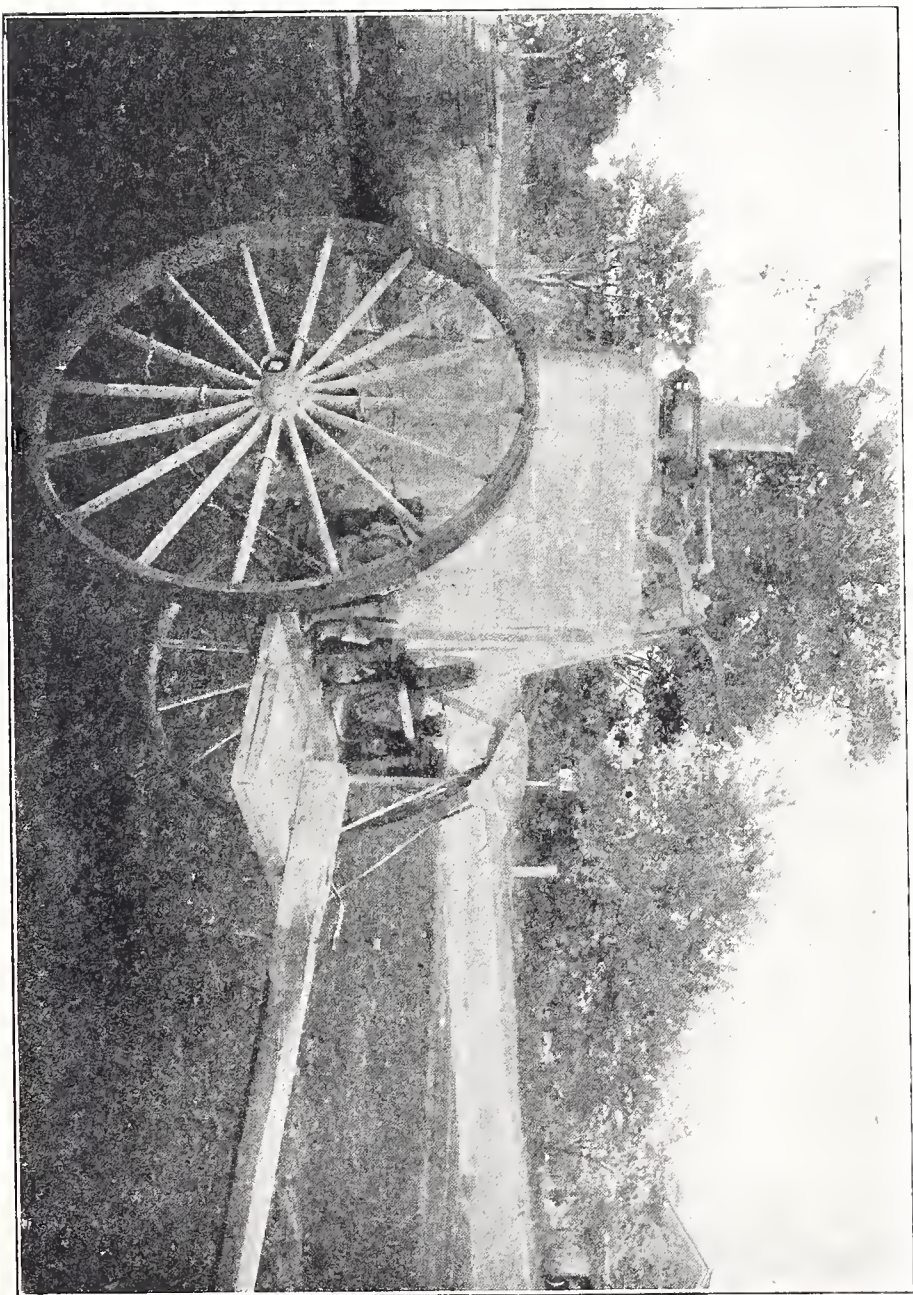


Fig. 31. A traction vineyard sprayer.



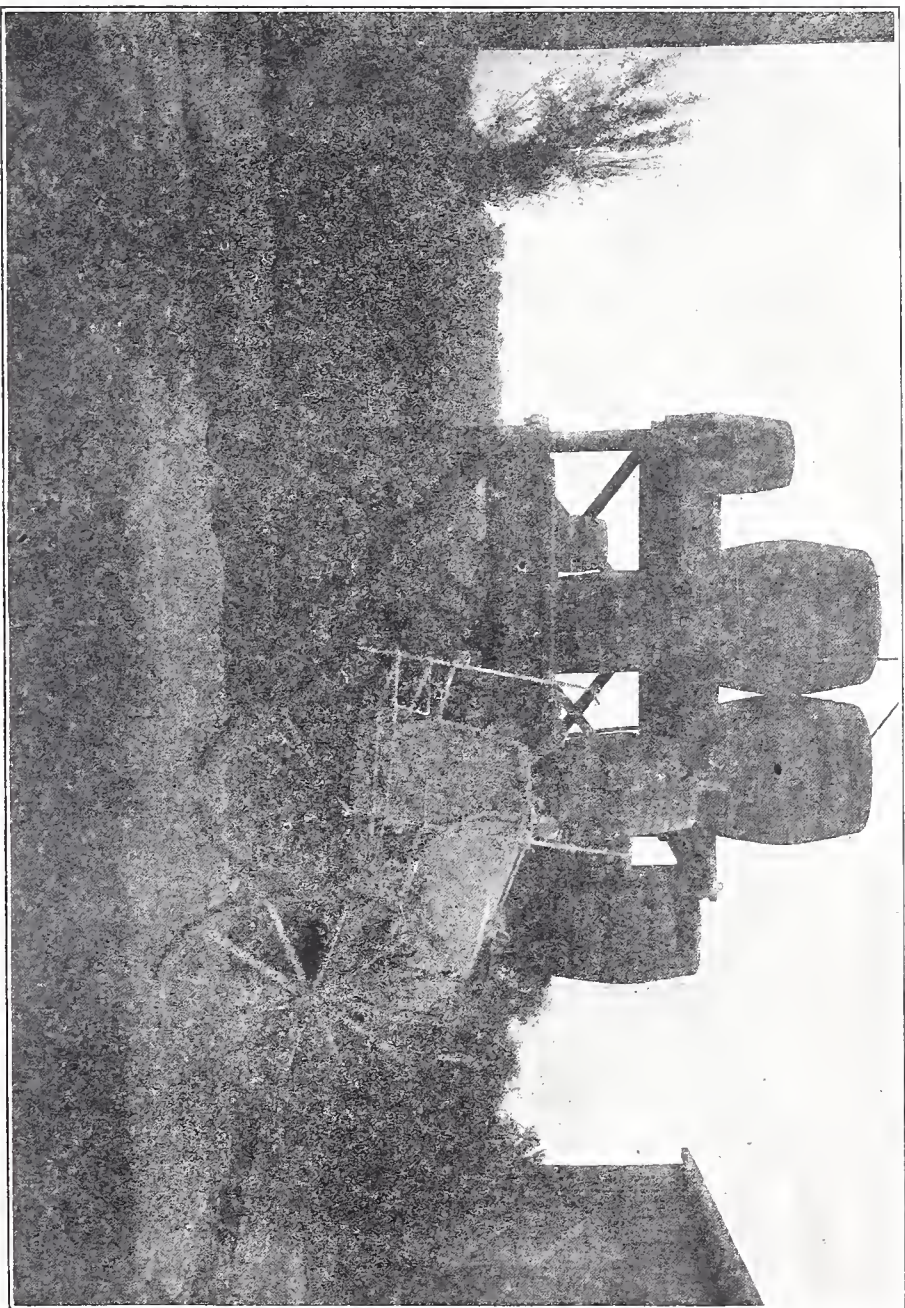


Fig. 32. A traction spray outfit with a spray plant in the rear.



Fig. 33. Grape foliage sprayed once with tobacco solution 1 to 100 on the John Higgins farm.

time may be run very close to the vine and be forced into the row between the vines in such a manner as to remove all the comb of soil and reduce the handhoeing to a minimum. The blade of the horse hoe is easily governed and may be forced into the row by the disc attached to the left handle, as shown in the illustration, Fig. 18. This disc is hung upon a moving joint which allows the disc to be thrown at different angles, thereby guiding the blade. The blade may be tilted to throw the soil up to the vine or to remove it.

Following the horsehoeing process is the hand hoeing. This is easily accomplished by a man following with a hoe and cleaning the soil away from the vine down to the bottom of the furrow, thus completing the hoeing process.

The vineyard land is now higher in the space between the rows than in the rows. Two general methods of working the soil back are used at this stage: First, the soil may be plowed toward the vines, the latter part of July; second, it may be thrown back a little at a time by the disc harrow until the soil in the row of vines is again higher than in the middle of the row. Cultivation stops early in August and cover crops are sown. Some of the most careful growers use the plank drag or float in the last cultivation, leaving the space between rows very smooth and level. This practice is condemned by many other growers who maintain that for the best physical conditions the soil should be left loose and uneven.

The Peabody cultivator, shown in Fig. 19, is much used by the growers for the midseason cultivation, especially after heavy rains when the soil has a tendency to firm and become hard. It is also very useful in rooting out weeds that have been allowed to get a start in the vineyard.

Shallow Versus Deep Tillage: The tillage of the vineyard should gradually become more shallow as the season advances. The feeding roots come up very near the surface at this time if not broken off by the cultivating machinery. The root system in itself is not exceedingly deep and requires intelligent and careful treatment if the grower desires optimum results. After the latter part of June the vineyard should never be cultivated more than three inches deep. Even the depth of the plowing and the horsehoeing should be governed by observing the root growth, taking care to see that none of the fine feeding roots are destroyed. The depth of cultivation should be shallow during the latter part of the growing season when the fruit is developing.

Results of Cultivation: Results of cultivation first of all are the conservation of moisture, equally important is the improvement of the mechanical condition of the soil, prevention of weed growth sap-
ping the vitality of the vine, destruction of insects which may be

hibernating in the soil, and the areation of the soil which is produced by the incorporation of organic matter and cover crops plowed under. In short, all the strength of the soil is thrown into vine growth and fruit production.

FERTILIZATION

Formulae Used: There is no uniformity in the practice of fertilization among the grape growers of this region, yet fertilization is very generally practiced. Only one man of the fifty growers interviewed was doing without fertilizer of some sort. Perhaps the one fertilizer most generally used is manure. However, it is not used in large quantities as a rule but is applied heavily about weak vines whenever needed according to the availableness. Most of this manure is made upon the farm where it is to be used.

Among the commercial fertilizers, the Keystone Special Fertilizer is very generally used. Its formula is 4.10 per cent. nitrogen, 5 per cent. equal to ammonia, 8 per cent. available phosphoric acid, and 8 per cent. actual potash, the potash is in the form of sulphate. Blood, bone and potash is a fertilizer as much used as the Keystone Special with excellent results. The potash may be used either as a muriate or as a sulphate, however, the muriate is most generally used. The sulphate used in connection with lime seems to be equal to if not better than the muriate. Nitrate of soda finds a valuable place among the other fertilizers for the rundown vineyard, producing an abundance of wood growth. Raw ground bone and kainite are often combined, but kainite seems to be falling into disfavor in the region because of the lack of beneficial effects. Basic Slag, although not largely used at present, should in the future prove to be valuable as non-acid source of phosphoric acid. Lime, although little used at present, should be more generally used upon the acid soils of this region.

Care should be taken about the application of nitrogenous plant food, such as stable manure, nitrate of soda, blood, and tankage. They are needed only when the vineyard is not making sufficient vine growth for the production of the new year's fruiting wood. If the soil is made too rich in nitrogen, the strength of the vine will go into the production of more wood than is necessary, while the fruit will not be produced to perfection. It has been used in varying amounts with good results from 100 lbs. to 250 lbs. per acre. It might be added, that the vineyard will show the need of nitrogen by the color of its foliage and by the growth it is making.

Not only is there a difference in fertilizing for vine production and for fruit production, but there is also a difference in the fertilizer treatment of different soils. For the optimum of fruit production

upon the gravel and gravel loams the fertilizer should run high in potash, about 200 pounds per acre being the usual amount applied. Phosphoric acid should be used quite heavily but need not be so heavily used as upon the clays. Cover crops and leguminose plants will furnish much of the needed nitrogen. Vines not making the required growth may be forced by the application of stable manure or nitrate of soda.

The clay lands require large applications of phosphoric acid; potash being present in varying amounts in most clay land. The amounts of fertilizer used by different grape growers varies a great deal, but for the blood, bone, and potash fertilizer there seems to be a general tendency to use 500 pounds. The Keystone Special is often used heavier, 500 to 800 pounds per acre not being uncommon. Lime, although not generally used, should be applied at the rate of 1,000 pounds per acre. A fertilizer analysing 2 per cent. nitrogen, 8 per cent. phosphoric acid and 4 per cent. potash applied at the rate of 500 to 800 pounds per acre is a good fertilizer for the clay land when used in connection with cover crops. For the gravel a 4-8-8 fertilizer or a 1-8-9 fertilizer is very much used. This fertilizer is said to balance the growth of wood and the production of fruit to the financial advantage of the grower.

Time of Application: Fertilizers are most usually applied in the spring when the soil is loose and before the spring rains are over. It is usually applied soon after plowing in the spring, the soil being harrowed afterwards to mix it thoroughly with the soil. When manure is used, it is applied during the winter and plowed under in the spring.

The broadcast fertilizer distributor is used to apply commercial fertilizer. This distributor is just wide enough to fill the space between rows of grapes without crowding. It is drawn by a horse and distributes the fertilizer evenly. Manure spreaders are sometimes used in applying manure before the planting of the vineyard, but cannot be used very successfully in the vineyard.

Advantages of Fertilization: Some of the results noted in the use of fertilizers are, that the fruit develops more perfectly, it holds up better in transit, and has more weight and better bloom. It produces better and more abundant wood. More uniform yields are secured by fertilization when the vineyards are kept in good condition.

Cover Crops: Nearly all of the largest and best growers are using cover crops in their system of culture, either every year or once in two years according to the need of the soil. The purpose being to produce the vegetable matter necessary to the proper physical condition of the soil, and at the same time to put into it the nitrogen needed by means of the leguminose crops plowed under. If cover

crops are wanted every year as a cover for the ground in fall and spring non-luguminose plants may be used every other year. These plants will add the humus content of the soil but will not add the nitrogen which causes an overgrowth of wood.

Plants for Cover Crops: The plants used for cover crops are given in the order of their importance as follows: Mammoth clover, crimson clover, hairy vetch, rye, cowhorn turnips, red clover, oats, buckwheat and chick weed. By importance, we mean the acreage sown in 1910. Mammoth clover is becoming very important as a cover crop in this region because it stands the winters better than the crimson clover. For some years past the crimson clovers have smothered under the excessively heavy snow fall of the Lake region. Mammoth clover, hairy vetch and red clover, all stand the winter well, covering the ground and furnishing vegetable matter as well as nitrogen to be plowed down. Oats make a successful cover crop if the only purpose is to cover the ground during the fall and winter and no growth is desired in the spring. It is non-leguminose and adds vegetable matter which easily works into the soil. Rye, cowhorn turnips and buckwheat are still used to some extent, but are condemned by many growers. Chick weed produces a natural cover for the soil in many parts of this region but it cannot be recommended for sowing.

Sowing of Cover Crops: Cover crops are sown at the last cultivation of the vineyard somewhere between the 25th of July and the 10th of August. Early sowing is of importance to insure an even stand before winter. The seed bed for the cover crop should be prepared as carefully as under general field conditions. Mammoth clover requires from 6 to 8 quarts of seed to the acre, usually sown broadcast between the rows. Crimson clover for the cover crop is shown at the rate of three pecks to the acre. Hairy or winter vetch is sown at the same rate, 40 pounds or three pecks to the acre. The other grains are sown somewhat heavier than under field conditions.

Merits of Different Plants as Cover Crops: Hairy vetch perhaps has an advantage over all the other cover crops used in this region. It is very hardy when sown early enough and produces a good stand which will grow all winter whenever the weather permits. It grows very close to the ground, giving protection to the frozen soil during the winter when it otherwise would be bare. Hairy vetch grows well when sown with other cover crops, it being often mixed with oats. The oats start rapidly in the fall shading the ground and keeping it moist until the vetch gets a good start. Vetch in addition to its value as a humus producing crop is a leguminose plant bearing nodules upon its roots which are filled with nitrifying bacteria. These bacteria aid in making available the nitrogen of the soil as well as fixing the nitrogen of the atmosphere.

Of the three clovers, mammoth, crimson and red, the first is being sown more generally at the present time than any of the others. When sown early it makes a good growth, covering the ground before winter sets in. This is not true without exception for dry weather in the fall may hinder it in its growth. However, it is the general opinion that mammoth clover is more sure than crimson in this location. In the southern parts of the state crimson clover is a success but cannot be recommended for all parts of the State.

Common red clover also forms a very successful cover crop in this region, although not so generally sown as the mammoth clover because it does not make so large a growth.

Among the non-leguminose cover crops, oats stand high in the esteem of many growers. Rye is still a standby with many growers, but others are very much against its use. It is difficult to plow under and does not decay readily. Buckwheat, like oats, produces a good cover in the fall, but is killed by the first frost. Cowhorn turnips are not nearly as much used now as formerly. Its greatest disadvantage is the difficulty experienced in cultivating the ground after the cover crop has been used.

TRELLISING

The trellising of the grape is one of the operations in grape culture in which the greatest variation is to be found. The methods of trellising in the east are more or less similar, the posts and wire system being used to support the vine. Many methods are used in starting the vine in different regions or by different growers in the same region. The vineyards in the west are often trained to a trunk upon which spurs containing three or four buds are left at the height of twenty-four or thirty inches. More often the vines are supported upon stakes about three feet high.

The Trellis: The trellis will vary with the method of training to be followed, but in North East region the posts are set every twenty-four to twenty-seven feet, with two wires of the trellis supporting three canes between each post. Care must be taken to set the posts in a straight line so that the wire may be easily stretched upon them. The posts are usually of chestnut, eight feet in length and are set eighteen inches to two feet in the soil. They cost ordinarily from eight to ten cents each. Other timber may be used if treated with creosote or other of the wood preservatives. In fact the life of the chestnut posts may be doubled if it is treated with creosote. The posts should be carefully sharpened before being treated so that they will drive straight. The end posts should be set in post holes and filled around with small stones carefully pounded down. The sharpened posts may be driven by a man standing in a wagon drawn be-

tween the rows. The wagon bed will bring the man to the proper height and no time is lost in moving from one post to another. A twelve pound maul is the most convenient size to use. The grape post should be somewhat heavier than the common post used in the construction of wire fence because it will have to hold the weight of the vine bearing a crop of fruit. The end posts at North East are braced in two general ways, (1) by a 4 x 4 scantling 12 feet long, which is notched into the end post near the top and braced against a shorter stake driven into the ground in the line of posts at such a place that the brace will hold the end post in its proper position. (2) By a strong wire around the end post near the top and extending outward some four or five feet where it is attached to an anchor buried in the ground.

After the posts and braces are set the wire should be put on and stretched taut with a wire stretcher as it would otherwise sag with the weight of fruit. The wire should be attached to the end post by winding it around the post once and then twisting the end around the trellis wire. Number 9 wire is most often used, running 17 feet to the pound. This wire should be attached to the windward side of the posts, using staples one-half inch longer than the ordinary. The staples should not be driven in tight enough to draw the wire into the wood of the post, because in tightening the wire in the spring the posts should be straightened up and the slack taken out of the wires.

The bottom wire is placed 28 to 32 inches from the ground with the top wire about 24 inches above it on the start. As the vineyard grows older and becomes more vigorous, the wire is raised nearly to the top of the post, giving more room to the vine for growth. The Chautauqua trellis will meet all conditions required in Pennsylvania, although many other systems might be described if space would permit.

The purpose of the trellis is to furnish a support over which the grape vine may be trained to produce the maximum amount of fruit with the minimum amount of vine wood. The trellis must support the vine so the air may circulate freely through the foliage and among the fruit clusters.

Some method of trellising should be used which will prevent great injury to the vines by heavy winds. The foliage should so cover the vines as to shade the fruit and to prevent sun scald upon the wood growth. As many methods have been used as there are grape regions and individual's preference.

Posts: However, it may be desirable in some parts of Pennsylvania where the surface of the ground is very uneven to train the vines upon posts, simply wrapping the vine around the post, and pruning to stubs.

TRAINING

The training of the grape vine is one of the operations in grape culture in which the greatest variations is found. The methods of training in the East are more or less similar in point of trellis, posts and trellis wires being used as described under the trellis. The details are carried out very differently in different regions or even among individual growers of the same region, each contending that his system is best. The many systems seem quite complicated to the beginner, when in reality they are all used for the same purposes. The western vineyards are trained to a stake almost universally. The vines being wrapped about the stake and pruned to spurs. Some vines are headed at from 24 to 30 inches and the shoots allowed to grow from the spurs supported by the vine itself.

The methods of training and pruning can scarcely be separated; yet there is a distinction and they will be treated separately. Prof. L. H. Bailey defines pruning as "a necessity" and training as "a convenience." With this in mind we will now consider some of the methods of training.

Nature's method of training the grape has been observed by all of us. We have all seen the wild vines clambering over old fences, stone piles and the like, or perhaps completely filling the top of some large tree. Under such conditions the clusters are far apart and the berries are small. The root is exhausting itself in production of vine and has little vigor left to produce fruit. In the commercial vineyard, modern pruning methods have been employed simply to reduce drain upon the root system. In other words, a balance is brought about between the vine and the root which makes fruit production possible. Our object is to force the vine to produce a maximum of large, well developed, perfect fruit without injury to the vine. The systems most usable for pruning conditions may be classed under two general heads: (1) The Drooping System. (2) The Upright System. Under the first class we will consider the Kniffin System and the Umbrella Kniffin System. The second class is represented by the High Renewal System, Chautauqua System, and the Chautauqua Improved System. Each of these systems will have ardent advocates in the same district. Special advantages may be claimed for each, but it will be largely a question of the readers choosing the method he desires to follow.

The Kniffin System: This system was originated in the Hudson River Valley about the middle of the last century by William Kniffin of Clintondale. Two wires are stretched, the first about 3 feet high, the second about $5\frac{1}{2}$ to 6 feet high. A single cane is now carried up from the ground to the top wire where the top of the vine is taken out and two lateral shoots are selected just under the top wire. These shoots are carried out upon the top wire and cut off at about

eight to twelve buds. Two shoots are selected in the same way from the vine just beneath the lower wire and carried out each way to the extent of four to six buds. Both of these pairs of shoots are now tied to the wires and we have a two story system of fruit bearing. The bearing wood or shoots will spring from the buds left in pruning and droop down laden with fruit. No attempt is made to support these shoots. The fruit is shaded under a heavy canopy of foliage, where it develops perfectly.

This system is very well adapted to vigorous varieties and is being studied by growers of other regions. It is the universal system in the Hudson Valley district. Each year spurs are left near the main arm to renew the canes. They are sometimes selected a little forward on the new wood, sometimes back on the old wood, as they happen to present themselves, care being taken to select only vigorous shoots. The heads, as first formed, remain practically intact for a long time, becoming gnarled and ungainly. When the vine begins to show signs of weakness it is best to renew the entire head and eventually the arm or trunk.

Umbrella Kniffin System: This system is a modification of the true Kniffin System, and might be called the Two Arm Kniffin System. It is used in the North East region by some growers. Several growers in this district are of the opinion that it is the best training system for the Niagara grape. It is used quite generally with this variety.

The two canes upon the lower wire are omitted in this system. The main arm or trunk is carried nearly to the upper wire, where two canes are selected forming the head. This head is often formed only two-thirds of the distance from the lower wire to the upper wire as seen in the illustration (Fig. 24.) The canes are then carried up over the top wire where they are tied, leaving from 10 to 15 buds on each cane. The fruit is borne upon the drooping vines under a good cover of foliage in most cases.

The High Renewal System: This system has reached great popularity in Central Western New York and is often spoken of as the Lake Keuka System. The vines in this system of pruning are trained upon a three wire trellis, the first wire being about 30 inches from the ground. The vine is trained nearly to the bottom wire in one cane or trunk. The vine is now pruned to two spurs of six or eight buds each. These two spurs are spread out quite broadly and tied.

As the shoots from these canes grow they are tied up to the middle wire and later to the top wire if the growth is sufficient. The vine should not be headed so low that the cultivating implements will injure it.

After the seasons growth is over and the leaves have fallen the eight or nine bud spurs left in the spring may be cut out, leaving one spur or cane upon each side to renew the growth the following season.

The buds left upon the spur the preceding season, of course, produced the fruiting wood and will be removed when the cane is cut back. The two canes selected are now cut again to six or eight buds and the former season's practice is repeated.

The Chautauqua System: This system has been the one used for many years in the North East region, as well as throughout the Chautauqua Grape Belt. It consists in training the vine to a two wire trellis; the first wire being placed at 30 inches and the upper wire near the top of the post. A single trunk is headed just below the bottom wire with two diverging trunks carried along and tied to the bottom wire. These permanent arms are often three or four feet long or even longer as shown in the illustration (Fig. 26.) From two to six canes are tied up from the horizontal trunk every spring according to the strength or vigor of the vine. These canes will contain five or six buds each, thus giving the vine from ten to forty buds from which their fruiting shoots will rise. Vines pruned in this way sometimes produce twenty to thirty pounds of fruit. The average, however, for an entire vineyard will be about fifteen pounds per vine. An expert pruner will size up a vine in a moment determining how much fruit it will develop without reducing the new wood growth. The average number of canes tied up from the horizontal arm or trunk to the upper wire is four or five.

The Chatauqua Improved System: This system is the one just described with the arms or trunks very much shortened or removed, until the vine when pruned to four or five canes and tied up presents nearly a fan shape. The tendency now is to reduce the number of canes to about three. Many of the growers in the North East region are now adopting this system and cutting out the old long arms. By this system the trunk is more easily renewed, less old trunk is open to insects and fungus diseases, and the fruit is brought nearer the root system. Several of the prominent growers consider the last point an important one, stating that they get better wood growth and more uniform development in the fruit. The vines for this system are planted seven feet in the row and nine feet between the rows.

PRUNING.

The object of pruning is to stimulate a maximum development of high quality, uniform fruit without draining the vitality of the plant. To do this requires close observation and understanding of the habits of the vine. The grape vine, although a rampant grower, is easily held in check. If the vine is allowed to overbear, little new wood will be produced and this little will be weak and unable to bear a good crop of fruit the following year. It is this that the expert pruner holds in mind when sizing up a vine before pruning it. He

knows that each vigorous bud that he leaves will produce from two to four clusters of grapes. He must know how much fruit the vine before him will develop without reducing its chances of producing strong new wood for next season's crop. The usual number of buds left on the Concord is twenty-five to forty; on the Delaware twenty to thirty buds should be left. However, there is more of a tendency to reduce the number of buds than to increase it. This insures not only perfect fruit (other things being equal) but also a vigorous growth of vine. Too vigorous a growth is apt to become watery and have a tendency to mildew. A balance is what is needed.

There are habits of growth of the vine which will help the beginner in pruning: (1) Bear in mind that old wood never bears fruit again. (2) That the wood which is produced and bears this year gives rise to bearing shoots for next year. (3) That if all the wood were left, the vine would produce ten times the fruit it should. (4) That by cutting away nine-tenths of the wood and leaving from thirty to fifty buds, the yield is increased. With these reasons in mind, we will go on and define some of the terms used.

The undersized wood, the growth of the current season, is known as a "shoot," and upon these shoots the fruit is borne. Each shoot will set from one to four or even five bunches—on the average from one to three—though there are occasionally shoots to be found without fruit. The clusters of fruit are borne upon the first few joints near the base of the shoot. This shoot continues to grow until fall and often reaches many feet in length. When ripened, or matured, the shoot becomes a "cane" and is so known through the subsequent season. Every bud upon the cane will spring into a bearing shoot the following season. The third year and thereafter, the cane becomes an "arm." The fruit, therefore, springs directly from the shoot, the shoot from the cane, and the cane from the arm.

Pruning may be done at any time after the leaves drop in the fall until the sap starts in the spring. The pruning is usually done during the winter. It is best to get it out of the way before spring, as other more timely work will be needing attention.

An expert pruner is usually employed, who superintends several other workers less expert than himself. The expert goes ahead and blocks out the vines, studying each vine separately and making the important cuts. He then moves on to the next vine, allowing the man who follows him to cut the tendrils and make the less important cuts, leaving the vine loose for the third man to remove them from the trellis. From three to five canes are left on the Concord. These canes are cut off at the right length to tie to the top wire.

The weak canes should first be cut out so that the vine will begin to shape itself. Then choice is made of the canes which most nearly meet the ideal of the pruner and the pruning system being followed.

All superfluous canes are removed and the canes bearing the strongest buds left. All diseased canes should be removed. If the arms are gnarled and decayed it is best to remove them where it is possible. Spurs should be left for next year's growth.

If the vines have been long neglected and are badly tangled it will be difficult to bring them under any regular system of training. In such a case the principles which enter into pruning, as outlined, should be considered. Healthy vines bearing the required number of strong buds may at least be found. If this is not practicable, then the vine may be cut down to the ground and allowed to sprout up to be trained according to the judgment of the grower.

The prunings from the grapes are removed from the vineyard by a "limbing pole," that is, a pole four inches in diameter at the butt and two and a half inches at the top and ten to twelve feet long. A one inch hole is bored four feet from the larger end through which a rope is run. A horse is hitched to the end of the rope at a distance great enough so that the pole may be allowed to dump or fly over endwise without hitting the horse. The small end is held in the hand and while the pole is drawn by the horse between the rows. If the first tangle of the vines is caught the rest will be easily gathered up and may be drawn to the burning ground and dumped.

Tying: The tying is done by women and children or cheap labor. The arms are tied with heavy twine to the lower wire and the upper end of the cane is tied to the upper wire with a No. 18 annealed wire. This wire is easily bent and does not react. The wire is cut four inches long. The operator works on the opposite side of the trellis from the vine, tying it upon the windward side. The tying is usually done in the spring after the pruning has been finished.

Summer Pruning: The value of the leaves in shading the fruit and causing it to ripen uniformly must be recognized, but it is sometimes advisable to summer prune such vigorous growing varieties as the Concord and Delaware. They sometimes overrun the trellis when planted in rich ground, thus reducing the size of the fruit. In such cases it will be wise to summer prune.

Summer pruning was formerly practiced to some extent in the North East district, but it seems not to be needed in the gravel soils of the lake regions and has largely been discontinued. In July or early August, the excessively long canes are cut off at two or three joints beyond the last cluster of grapes. This tends to throw more food into the development of the fruit. Some of the heavier soils having a rich supply of nitrogen produce vines ten to twelve feet in length.

Suckering: This is done in June when the young growth starts up from the base of the trunk. These tender shoots may be rubbed off

with the hand. It is usually done by small boys. In case the trunk is diseased or needs renewal, one of the stronger suckers may be allowed to grow to produce a new top.

Bagging: This is a practice sometimes used to protect grape clusters from insects and fungus attacks or from poultry in case they have access to the vineyard. However, it is of little importance in the commercial vineyard managed under modern methods. Spraying methods now protect them from the fungus and insect troubles. Fruit enclosed in paper bags is better developed and has better bloom than that not enclosed. Some vineyardists find that it pays to bag some fruit for special trade.

Manilla bags, holding a quart, are used. They are placed upon the vines as soon as the fruit is as large as squirrel shot, usually the latter part of June.—The sack should be slipped over the cluster, the stem protruding from the sack in the center of the open end. The upper two corners of the open end, held between the thumb and forefinger of each hand, should then be brought together and folded over dog ear position. A pin is now thrust through with a single rapid pressure of the right hand while the bag is supported by the left.

Ringling: This is an operation that is not practiced commercially, but may be of use in a small private vineyard to produce large perfect clusters of fruit one or two weeks earlier in the season than is usual for the variety. It does not work equally well with all varieties of grapes.

The process consists in the girdling of the cane or removing a ring of bark about an inch wide from the bearing branches when the fruit is first set or before it reaches one-third of its natural size. During the later part of June the bark separates easily from the wood. A knife is run entirely around the cane at intervals of an inch apart, care being taken that only the bark shall be removed, and that the young wood or inner combine layers shall not be injured. This bark is now taken out, leaving the wood of the cane bare far enough so the healing ends will not come together. This ringling should be done far enough out upon the cane so that the cane will be pruned off the following spring. Sufficient wood must be left underneath the girdle to keep the vines in health and renew the arms. Ringling is a devitalizing practice and should not be practiced on the same vine year after year.

The process depends for its worth upon the fact that plant food taken up by the roots is carried to the leaves through the outer young wood (sap-wood) where it is elaborated and sent downward through the bark. With the ring of bark removed the sap is arrested in the cane where it is utilized by the fruit clusters.

SPRAYING IN NORTH EAST

At least 80 per cent. of the growers of grapes in the North East region spray, using Bordeaux mixture of varying formulas. Some Lime-sulphur has been tried in the region, but is not used upon grapes to any extent. Spraying is quite carefully done at North East by the best growers. The arsenicals are mixed with the Bordeaux, making a combination spray as described later. The number of applications vary from one to five during the season beginning any time after the new shoots are six or eight inches long and extending to the time when the berries are as large as peas. After the spraying is started it should be kept up once every ten or twenty days. The Bordeaux mixture should be applied in a mist like spray which will cover the surface of all the leaves much as a heavy fog will show upon a leaf. The sprayer used should be capable of holding a pressure of 100 to 150 pounds.

Spray nozzles of the "Friend" type should be used for Bordeaux mixture or the combination spray. Fixed nozzles are used in spraying for the fungus diseases and all insects except the Leaf Hopper, where movable nozzles of the Spray Motor type are used to apply the Tobacco Extract. Great care must be used in spraying for the leaf hoppers. The under side of the leaf must be thoroughly covered to destroy the hoppers. The sprayer is driven ahead and the man using the movable nozzles works up to it directing the spray nozzles upward under the foliage. To control biting insects it is best to use arsenate of lead. This form of the arsenic can be used in greater strength without injuring the foliage than either the arsenite of lime or the Paris green. Both of the latter mentioned contain a higher percentage of soluble arsenic which is injurious to the foliage. If not used in too great strength either one will be moderately successful. The arsenate of lead should be procured from a reliable firm in the form of a paste. It is then easily mixed with the spray materials.

Bordeaux mixture, which is a fungicide, varies in strength, the following formula being used: 4-4-50, 6-3-50, and 5-5-50. The latter is most used and is combined with arsenate of lead in the following proportions:

Arsenate of lead,	3 pounds.
Copper sulphate (blue vitriol),	5 pounds.
Fresh stone lime,	5 pounds.
Water,	50 gallons.

This combination controls both the fungus diseases and the insect enemies. It is used throughout the season unless spraying is carried on quite late, when the Burgundy mixture is often substituted. This mixture does not stain the fruit and is nearly as effective in the

control of fungus as the regular Bordeaux mixture. The following is a description of the preparation of Bordeaux as given by Mr. C. L. Shear of the Bureau of Plant Industry.

(x|x Bul. 284. Farmer's, for preparation of Bordeaux Mixture.)

Preparation of Bordeaux Mixture: Failure to secure satisfactory results from the use of Bordeaux mixture is frequently due to lack of proper care and thoroughness in its preparation, or to the use of poor material. All ready made preparations of Bordeaux mixture in the form of a paste or a dust should be avoided, as a chemical constituent does not properly combine in these conditions. A definite chemical compound is desired, and this only can be produced in proper form and condition by carefully following the directions given below.

Stock Solutions: In order to carry on the work with the greatest convenience and economy, a considerable quantity of copper sulphate and of lime should be ready for immediate use. The copper and the lime may be prepared and kept most conveniently in the following manner:

Copper Sulphate Solution: Take 100 pounds of copper sulphate (blue stone), place it in a gunny sack, and suspend it in a 50-gallon barrel of water. Kerosene or whiskey barrels will be found very convenient. The copper sulphate will all dissolve in from 12 to 18 hours if suspended in a loosely woven sack, but if it is thrown loose in the bottom of the barrel it will take several days and considerable stirring to dissolve it. This makes a solution containing 2 pounds of copper sulphate to each gallon of water. This may be kept as long as desired without deterioration, if covered so as to prevent evaporation.

Lime Solution: The various kinds of ground and prepared lime cannot always be relied upon; stone lime is therefore preferred, and is more likely to give uniformly satisfactory results. Slake 100 pounds of stone lime in a 50-gallon barrel, adding the lime in small quantities with plenty of water and mixing thoroughly. When the lime is all slaked fill the remainder of the barrel with water. You will now have a stock preparation of lime which when thoroughly mixed will be thin enough to dip and pour readily. Each gallon of this preparation will contain 2 pounds of the stone lime. This may be kept under cover and used as needed. Where large quantities of material are being used it is desirable to have two or more barrels each of stock lime and blue stone instead of one, so that the blue stone in one barrel may be dissolving while that in the other is being used.

Mixing Copper Sulphate Solution and Lime Solution: To prepare a 100-gallon spray tank of Bordeaux mixture, take two 50-gallon barrels and fill them nearly full of water; to one barrel add 5 gallons

of the blue stone stock solution, which will be the equivalent of 10 pounds of bluestone. To the other barrel add 5 gallons from the barrel of the stock lime preparation, which will be equal to 10 pounds of stone lime. Mix the lime thoroughly and allow the contents of the two barrels to run together into a trough, or through hose attached at the bottom of the barrels into the tank of the sprayer. If an insecticide is to be used, it may now be added to the mixture. After the mixture is prepared it should be used very soon, and not be allowed in any case to stand more than a few hours before using.

The quantities mentioned in this account of the preparation of Bordeaux mixture will give 100 gallons of the 5-5-50 formula. For the other formulas, the manner of preparation is precisely the same, and the necessary changes in quantities of bluestone and lime are easily calculated.

Straining: In order to avoid clogging the spray nozzles the mixture must be thoroughly strained before it goes into the sprayer. A strainer of brass wire cloth, 20 or 22 meshes to the inch, should be used for this purpose. A very convenient and satisfactory strainer can be made according to the following description: It consists of (1) a tight outer box about 1 foot square, with a heavy bottom, into which a piece of $1\frac{1}{2}$ to 2 inch gas pipe is fitted as an outlet, and (2) an inner box, smaller and lighter, which will drop easily into the outer one. The wire cloth, securely fastened, forms the bottom of the inner box, and is sloped at an angle of about 30 to 35 degrees. The slanting of the sieve prevents clogging, and the removability of the inner box greatly facilitates cleaning. A narrow strip should be nailed about the outside of the inner box at the top, so as to prevent its dropping too far down; this will facilitate its removal.

Elevated Platform: A platform similar to the one shown in the accompanying illustration (Fig. 32) will be found very convenient in handling the stock solutions and the mixture. This should be located near a good water supply. A tank elevated above the mixing platform and filled by a windmill pump will be found very convenient, or the platform may be located beside a stream or spring and the water be raised by means of a force pump.

BURGANDY MIXTURE (Copper Carbonate Mixture).

Copper sulphate,	2 pounds.
Sodium carbonate (Sal Soda),	3 pounds.
Water,	100 gallons.

This is a nonstaining preparation sometimes used late in the season upon grapes in place of the regular Bordeaux.

The spray used for the Grape Leaf Hopper is composed of a tobacco solution. Two different tobacco preparations are used successfully,

both manufactured by "The Kentucky Tobacco Product Co.," of Louisville, Ky. Black Leaf Tobacco Extract is used one gallon to one hundred gallons of water. It costs \$3.50 for five gallons and is applied as explained under Grape Leaf Hopper. "Black Leaf 40" is \$12.50 for ten and one half pounds or eleven pints. One pint is used to one hundred gallons of water.

INSECT ENEMIES

The control of the injurious insects is one of the important factors in the production of grapes. With insects prevalent in the commercial vineyard little real profit can be realized. These insects may be very successfully controlled by the use of liquid sprays described in the foregoing pages. These liquid sprays may be so made as to combine both the qualities of an insecticide and those of a fungicide in the same spray, thereby reducing the cost of application by one half. Of the two hundred or more insects which are known to feed upon the grape in the East, the Grape Root Worm, Grape Berry Moth, Grape Curculio, Grape Leaf Hopper, Grapevine Flea Beetle, and the Rose Chafer or Rosebug will be considered. The Grapevine Phylloxera, an "aphide or plant louse" which infests the roots and leaves of Vinefera Grapes, fully as important as any of the others named, is purposely omitted because it is not an important insect in the East where European varieties of grapes are not grown. For the convenience of the grower reading these pages, the insects will be divided into two groups requiring different spray treatment: (1) Those having "biting mouth parts," destroyed by stomach poisons such as arsenics, arensate of lead, white arsenite, London Purple Paris green, and such poisons. This group of insects includes all of those devouring the foliage or parts of the vine or fruit, such as the root worm, grape berry moth, Grape Curculio, Grapevine Flea Beetle and Rose Chafer. (2) Those insects having a long tube like proboscis through which they suck the juices of the plant. Such insects are said to have sucking mouth parts and are treated with such contact sprays as kerosene emulsion, whale oil soap, tobacco solution, and lime-sulphur washes. Two grape insects come in this group, the Grape Leaf Hopper and the Phylloxera. The contact sprays must either smother the insect by stopping its breathing spiracles or by corroding the chitinous covering of the insect.

Grape Root Worm (*Fidia Viticida*): This insect is one of the most important of the injurious insects infesting grape vineyards under Pennsylvania conditions. For a detailed study of the Grape Root Worm, and its control, the reader should consult Bul. 89 of the Bureau of Entomology, written by Fred Johnson and A. G. Hammar. Late in June or early in July chainlike markings may be seen upon the upper surface of the foliage. These markings are made by



Fig. 34. Grape leaf hopper injury which was prevented on the John Higgins farm by tobacco solution.



Fig. 35. A fair yield.

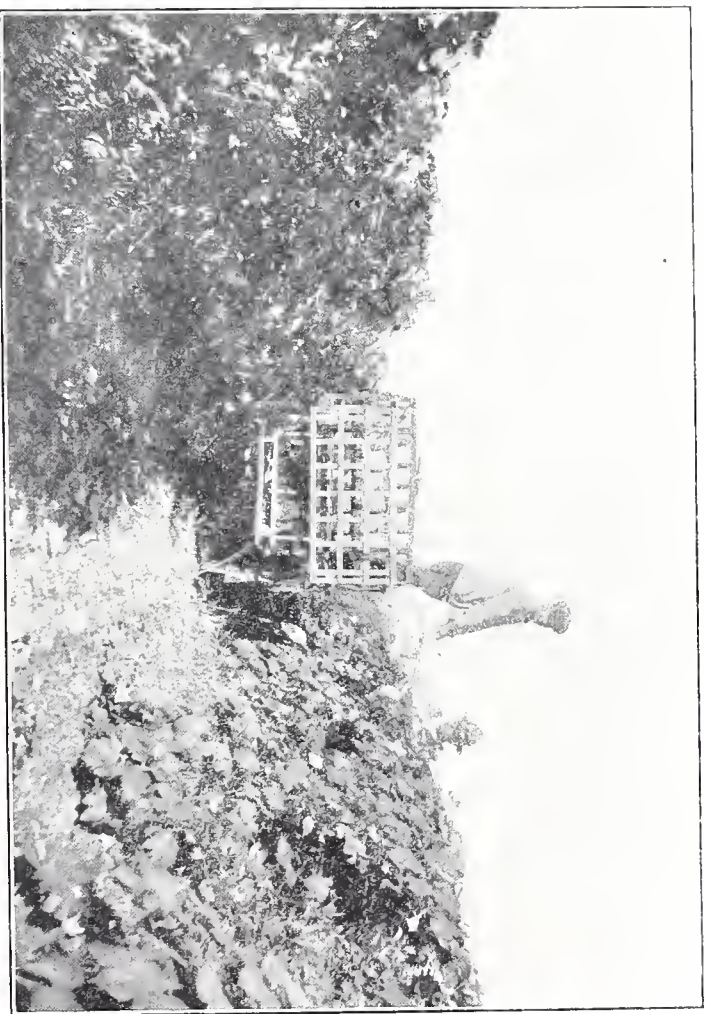


Fig. 36. Collecting the baskets from the vineyard.



Fig. 37. The stand upon which the grapes are picked.

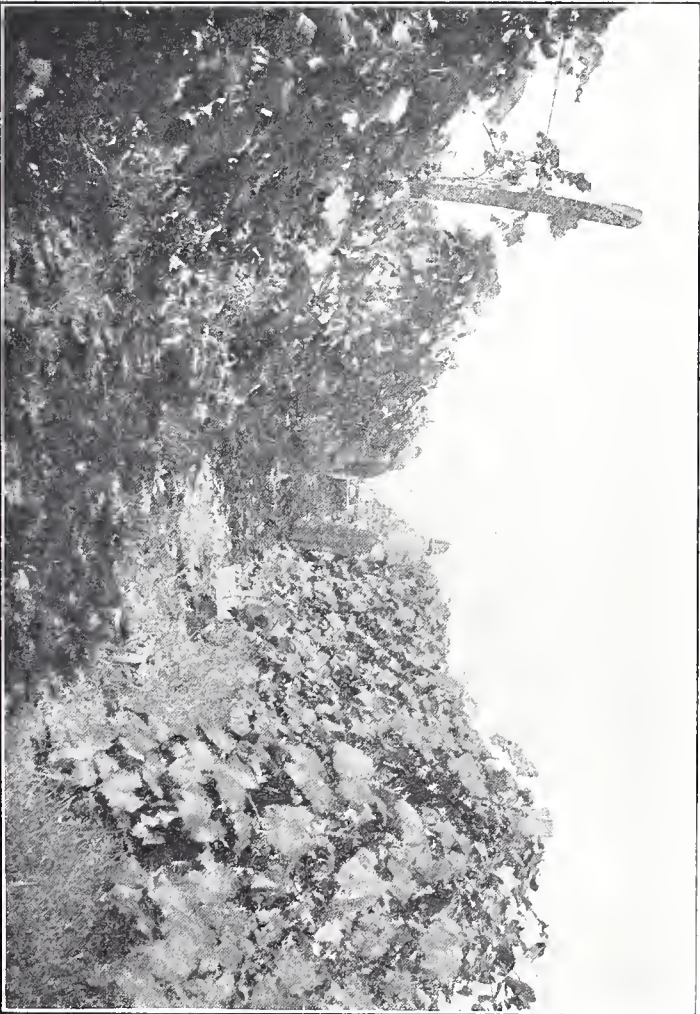


Fig. 38. A picking scene showing fruit ready to be taken from the vineyard.

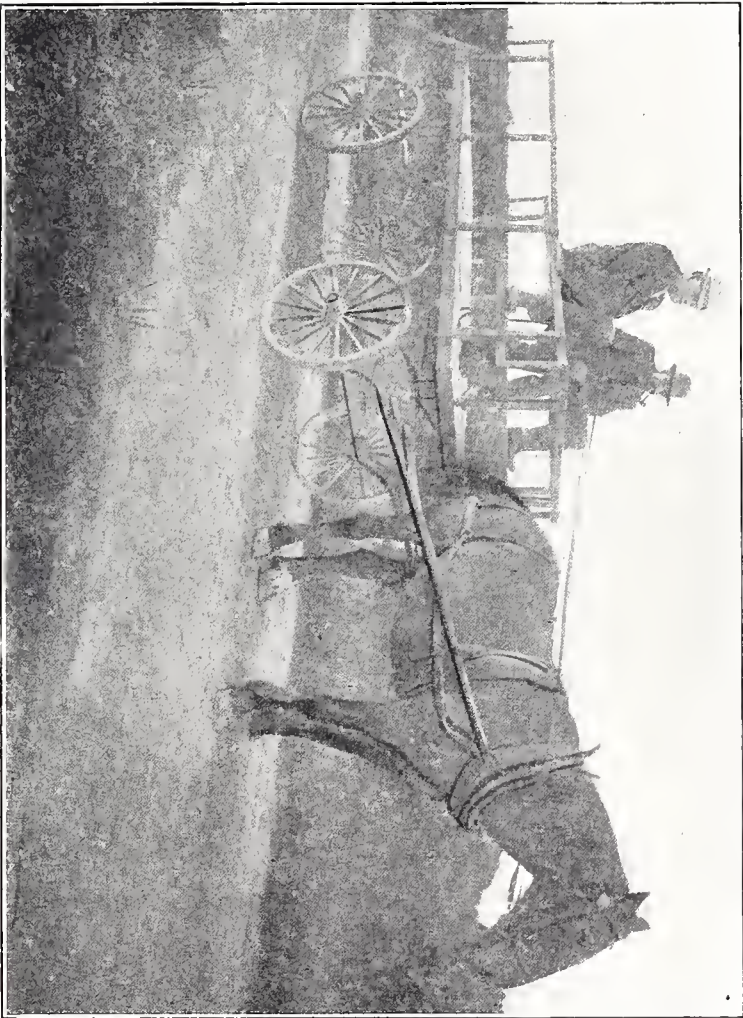


Fig. 39. A grape wagon used in the vineyard.

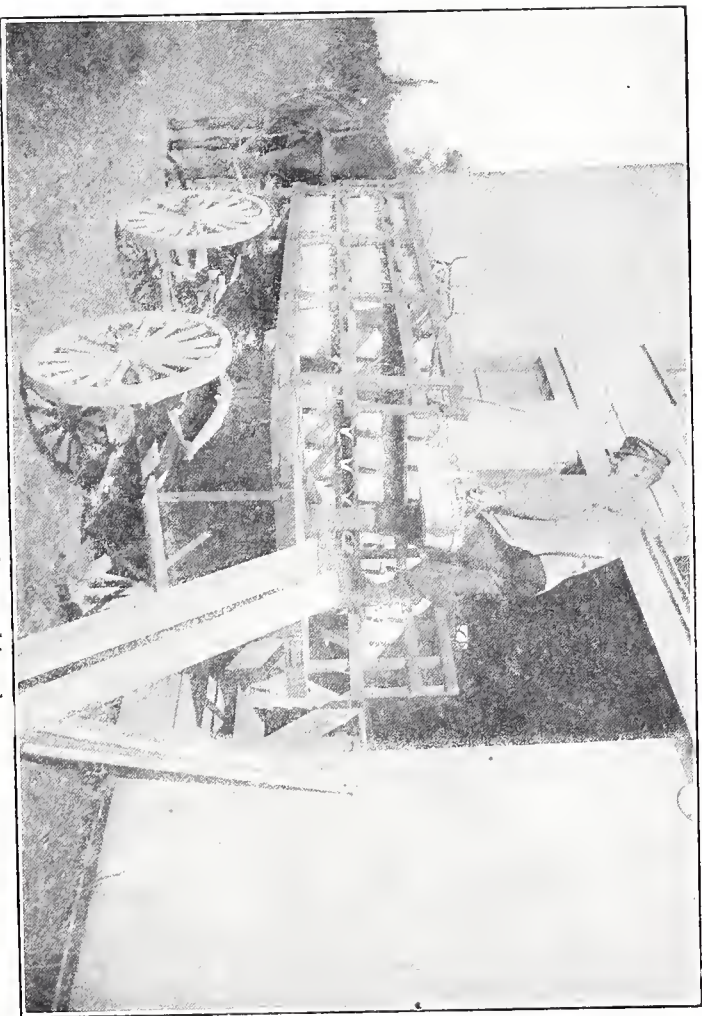


Fig. 40. Unloading at the packing house.

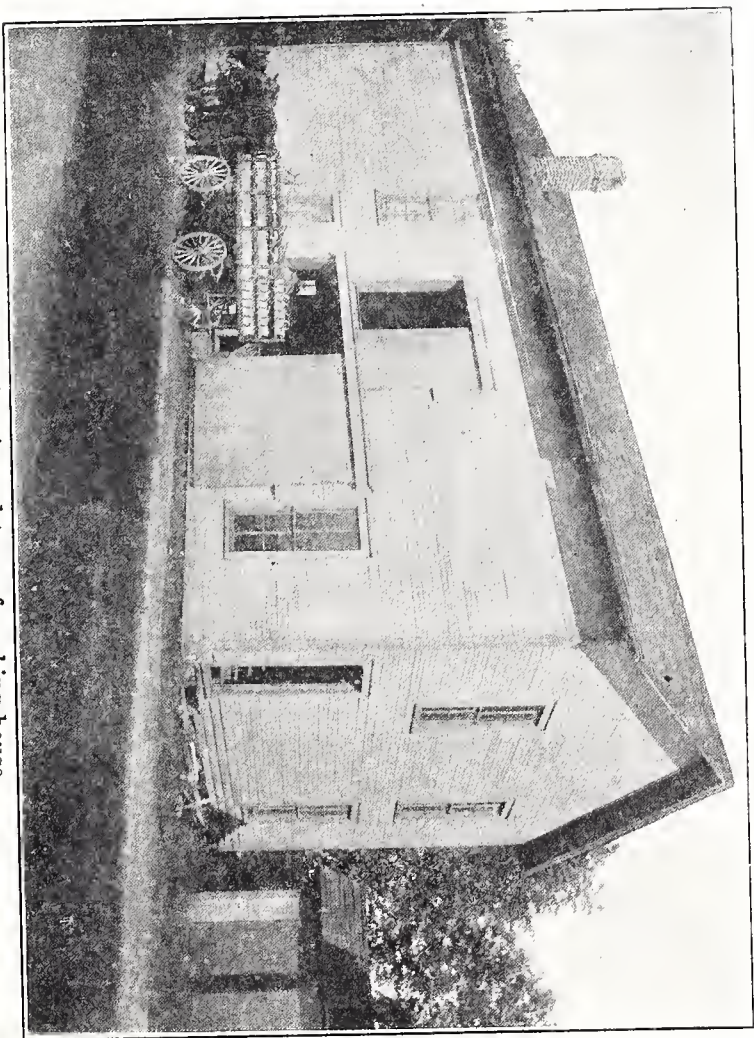


Fig. 41 A. A good type of packing house.



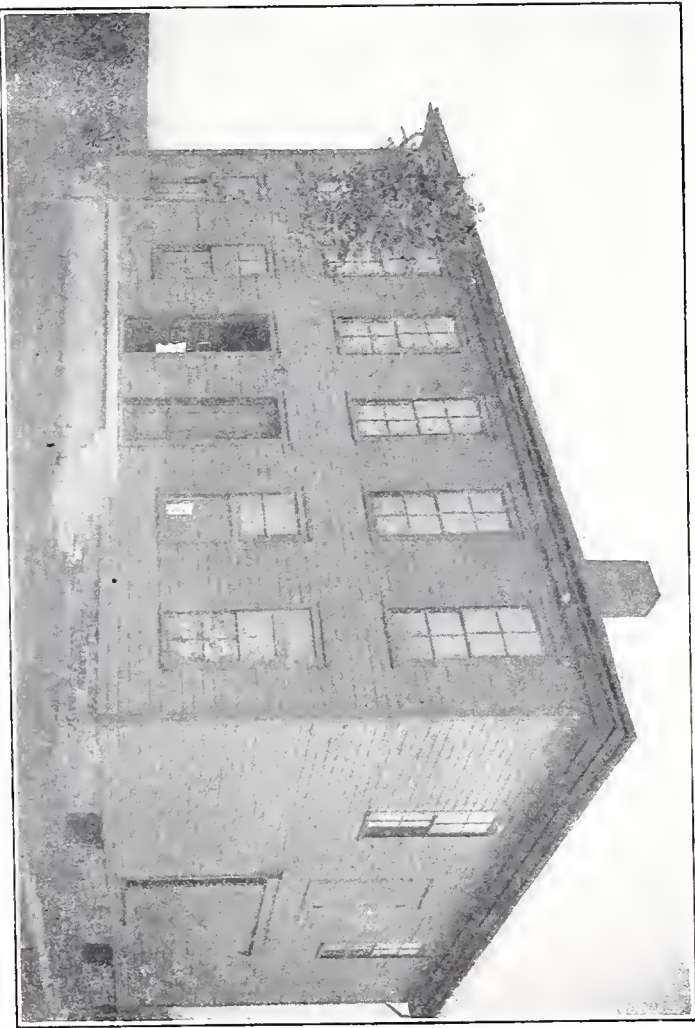


Fig. 41 B. A good type of packing house.

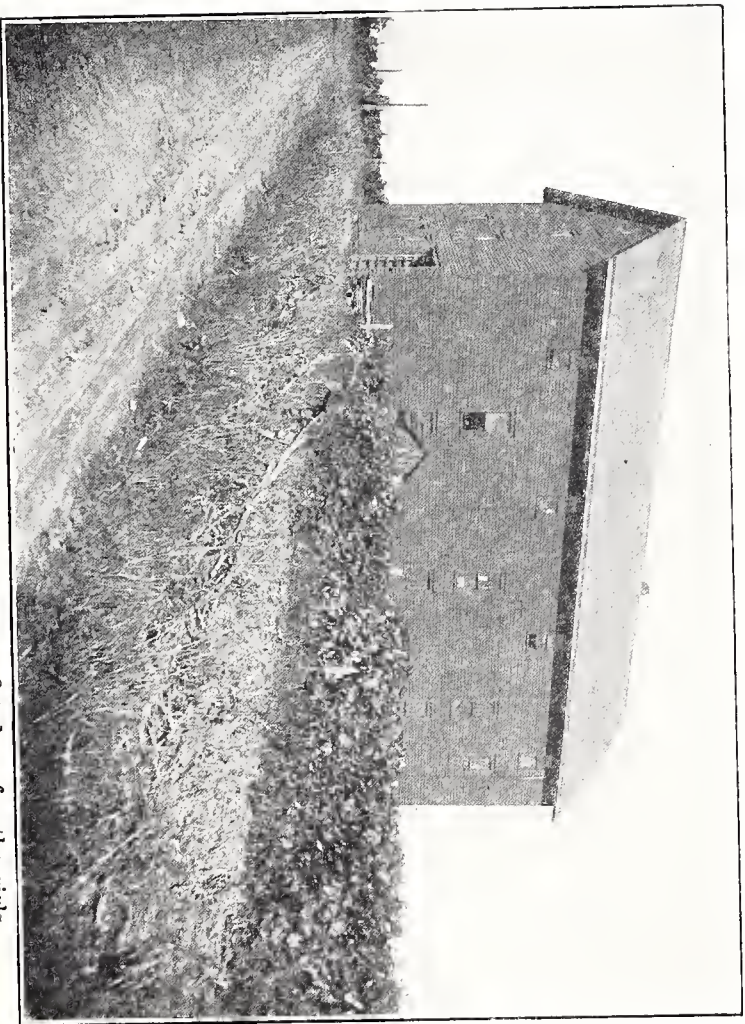


Fig. 42. A packing house in which rooms are fitted up for the girls.

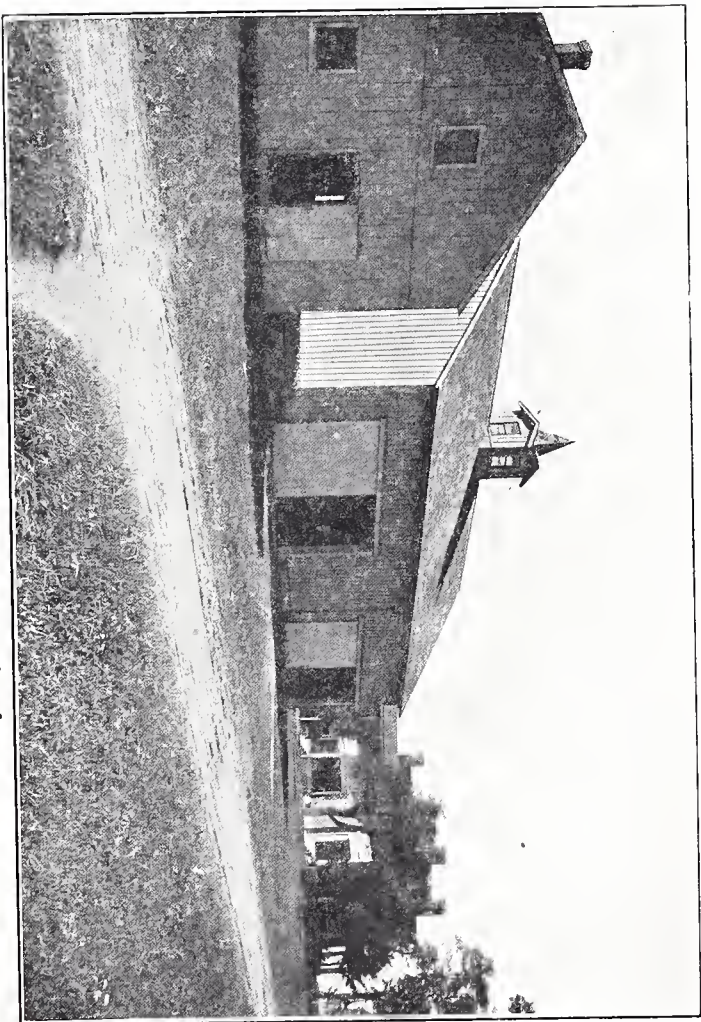


Fig. 43 A barn used as a packing house.

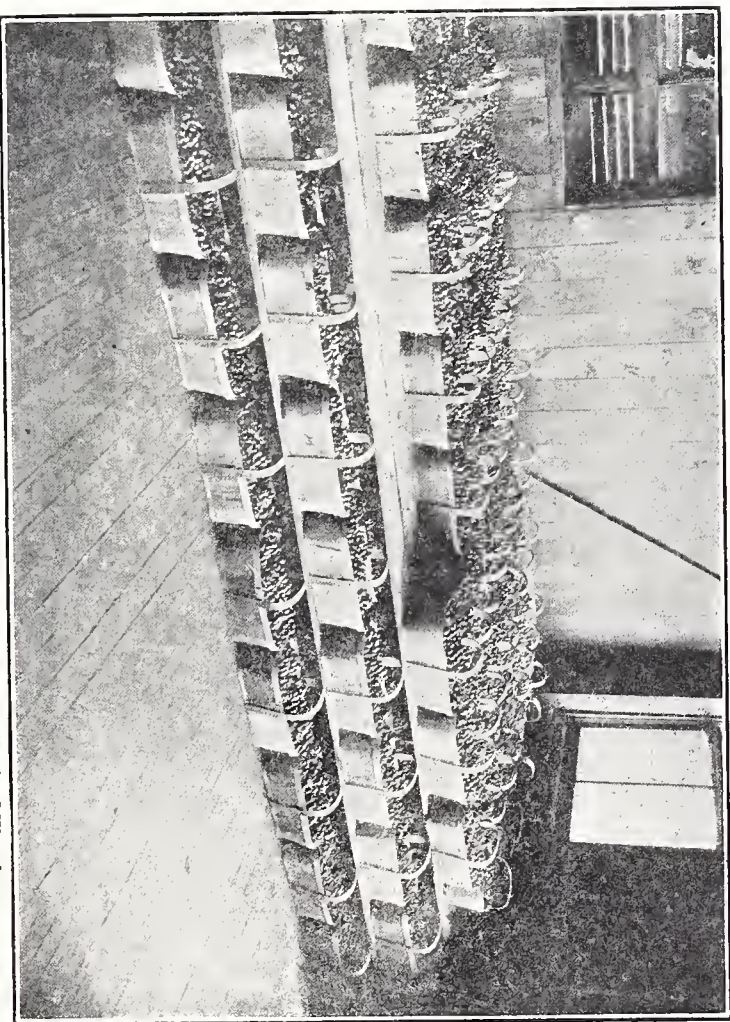


Fig. 44. Fruit setting in the packing house of W. S. Wheeler.

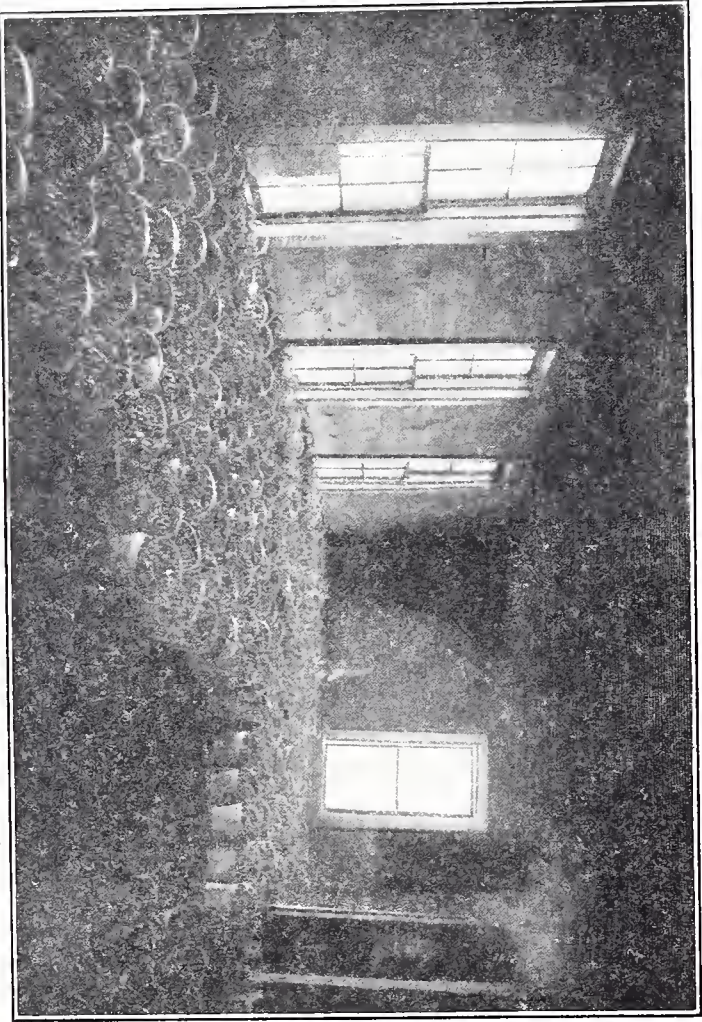


Fig. 45. Fruit settling in the packing house at the Haskell vineyard.

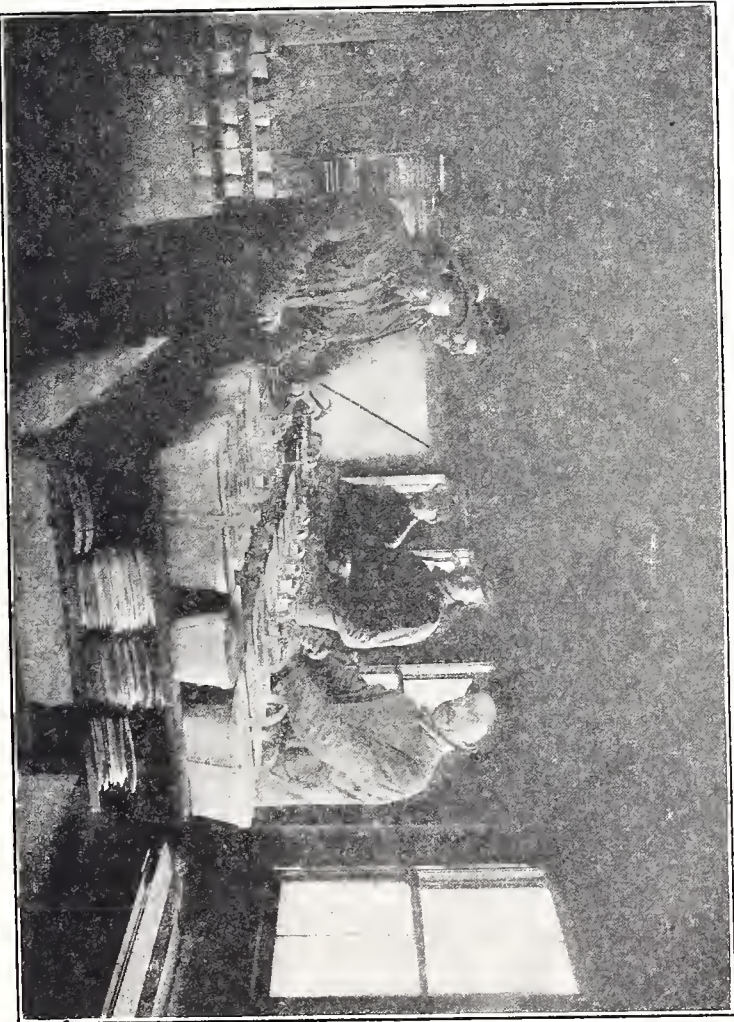


Fig. 46. Covering grape baskets.

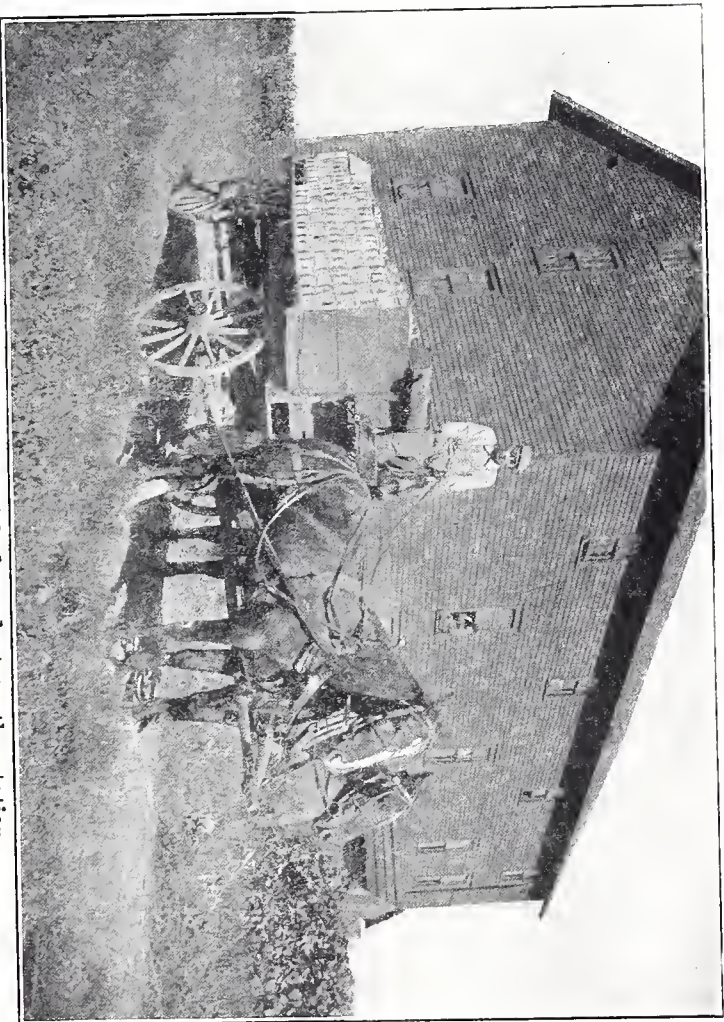


Fig. 47. Hauling the finished product to the station.

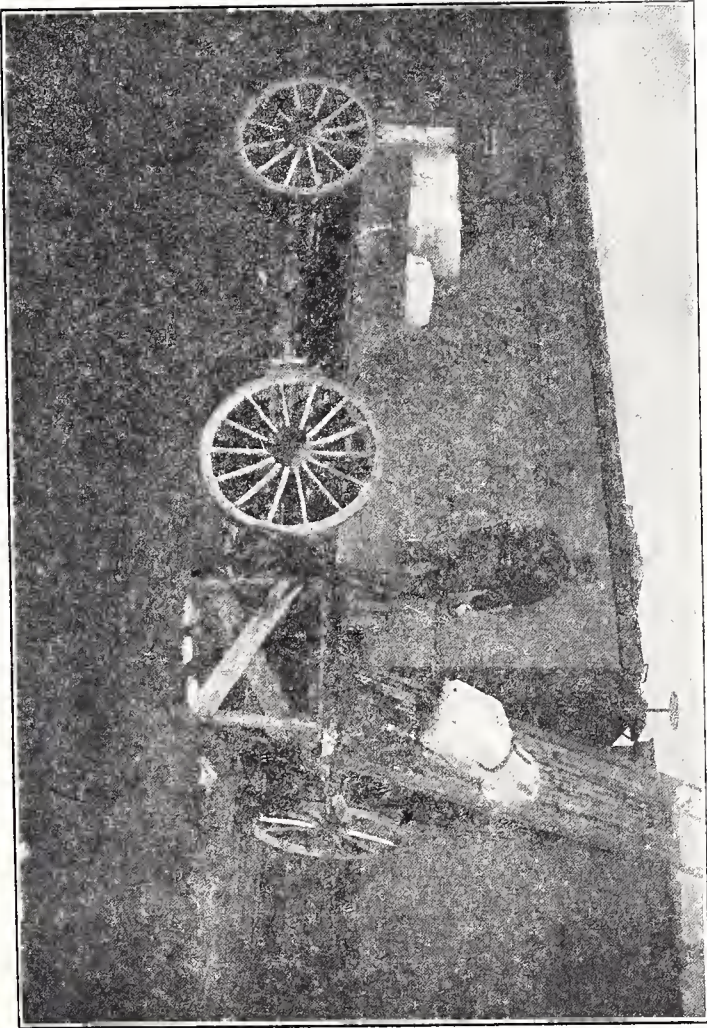


Fig. 48. Icing the cars for grapes.

the Grape Root Worm Beetle. This feeding, unless very severe, does not materially injure the vigor of the vine. Prof. Fred Johnson states that it is, however, the larvae of this pest feeding upon the roots of the vines that is the direct cause of the injury and death of so many of the vines. The work of the larvae upon the roots may be recognized when the vines are removed from the soil, by the absence of root fibres, by channels along the larger roots, and by pittings on the main trunk. The vine may withstand the ravages of this insect for some time by throwing out fibrous roots near the crown of the plant or from the larger lateral roots.

Description and Life History: The adult is about one-fourth of an inch long, rather stout, with long legs. The body is brownish in color and covered with grayish white hairs. The full grown larvae is five-eighths of an inch long, the body whitish, resting in a curved position. The head is yellowish brown in color as are also the spiracles or breathing pores along each side. The insect at this stage resembles, in miniature, the common white grub, from which it may be distinguished by the dark food material in the abdomen of the latter. According to Prof. Johnson, the beetles emerge at North East between June 28 and July 10 in the largest numbers. The beetles emerge somewhat earlier upon the gravel soils than upon the heavier soils. When the beetle comes from the soil it immediately begins feeding upon the first grape leaf encountered. It is at this time that the poison spray is effective. The voracity with which the beetle feeds when it first emerges would suggest that the vines should be previously well covered with the poison spray. The beetles **after** feeding nine or ten days deposit their eggs under the loose bark of the trunk or canes of the vines in clusters averaging about twenty-four eggs. Nearly all the eggs are deposited before August 1. The eggs hatch in about twelve days on the average varying according to the prevailing temperature. The larvae in hatching drop to the ground and make their way through the ground to the roots of the vine through crevices. The young larvae feed largely upon the smaller root fibres, sometimes reaching three-fourths the full size and frequently full growth before winter. The larvae go deeper into the soil late in October where they hibernate in an earthen cell. Here they remain until early May, when they again begin feeding and complete the life cycle by going into the pupal stage early in June, and coming up as adult beetles early in July.

Remedies: Cultural operations are important, that is, the practice of "Horse Hoeing" the grapes during June, as it destroys the Grape Root Worms then in their pupal stages. See cultivation for a description of "Horse Hoeing" operation.

The vines should be very thoroughly sprayed upon the first appearance of the beetles or as soon as a few of the beetles are noticed.

The following combined fungicide and insecticide is used since it is absolutely necessary to hold in check fungus diseases as black rot, downy mildew, etc. The formula recommended for this combined treatment is made to the 3-5-5-50 formula described under spraying.

Grape Berry Moth: This insect is responsible for a large part of the wormy grapes in the Eastern United States. The pest has a wide distribution, and has been proven by Slingerland and Kearfoth to be distinct from the European form. The first generation of the Berry Moth web the young fruit clusters together about the time the fruit is set. When the berries are one-half to two-thirds grown, purplish spots are to be seen upon infested berries. These spots grow larger as the larvae develop and the berry splits open allowing the seeds to show. The larvae feed upon the interior of the grape and upon the pulp and the seeds, sometimes passing from one berry to another which may lie against the side.

Description and Life History: The Grape Berry Moth is a purplish brown color, with lighter markings, about one-half inch in spread of wings. The early brood of moths appearing from the over wintering pupa about the time that the shoots are starting well in the spring oviposites upon the young clusters of grapes. Here they may do great damage by webbing together the small berries and destroying whole clusters. However, the moths do not usually appear in very large numbers in the spring, due no doubt to the heavy death rate during fall and winter. Eggs are deposited during the summer upon the berries where they are easily seen as a whitish spot upon the fruit. The larvae hatch and feed upon the berry, as before stated, for about three weeks, after which the larvae pupates by cutting a sort of a crescent-shaped piece from the leaf and folding it over upon itself. Here it spins a cocoon in three or four days and transforms to a pupa. It completes the life cycle by emerging in the spring as an adult moth, and ovipositing upon the young grape clusters.

Remedial Measures: Spraying for the Grape Berry Moth should take place before the blossoms have opened. The second application should be applied just after the blossoms have fallen. This application should be followed by another after about three weeks in badly infested vineyards. Arsenate of lead should be used at the rate of five or six pounds of the paste form to fifty gallons of water. These arsenicals may be mixed with Bordeaux mixture and applied so as to control the fungus troubles as well. The last two spray treatments named will also control the grape root worm.

Grapevine Flea-Beetle (*Haltica chalybea*): The buds of the grapes are scooped out and eaten by this insect early in the spring, materially retarding the leafing out of the vines or even causing the death of the plant. The foliage is later eaten by the beetles. The eggs are deposited upon the leaves, and according to Slingerland, in

the cracks in the bark at the base of the bud, between bud scales, or even in holes which have been eaten into the buds. The larvae eat holes in the young foliage and may be easily destroyed by arsenicals. Only one brood is produced under northern conditions. The insects pass the winter in the adult stage, hibernating much as the Grape Leaf Hopper.

Description: The beetle is a shining blue black creature about one-fifth of an inch long, having the habit of most flea-beetles of jumping when approached.

Remedy: The insects are destroyed by arsenicals. They will be easily kept in check where the vineyard is regularly sprayed with Bordeaux and arsenate of lead. The first spraying should occur as soon as the beetles appear, and the second when the young larvae are observed. One pound of the arsenate of lead in fifty gallons of spray mixture or water with lime will be effective upon the beetles or larvae.

Leaf Hopper (*Typhocyba comes*): This insect was especially troublesome during the summer of 1910 in the North East district. It was found in great numbers infesting the under surface of the grape leaves and producing a rusty brown or scorched appearance to the leaf. The insect has a proboscis or tube-like mouth parts through which it sucks all of its food. The insects feed and breed upon the leaves increasing rapidly under the right climatic conditions until they literally swarm over the vines. This insect is not very destructive every year, but it is always found. Only when it appears in immense numbers does it do great damage. Vineyardists, unless on the lookout, may be surprised in late summer and fall to find many brown and blotched leaves dropping prematurely. This is too late, because the injury is already done. These insects, when occurring in large numbers, extract large quantities of liquid food from the tissues of the plant through their tube-like mouth parts. The loss of leaves and healthy leaf surface to elaborate plant food results in a reduction of quality, flavor and sugar contents in the grape.

Description and Life History: The adult Leaf Hopper is quite small, measuring not more than one-eighth of an inch in length. The principal color is light yellow with the back and wings variously marked with red. The pattern and color varies much with the different individuals and at different seasons. The colors become uniformly darker as the season advances. They hibernate as adults during the winter in trash such as grape leaves, dead weeds and grass, and in adjoining woodland, old fence rows, etc. They come from their hiding places early in the spring upon any succulent vegetation at hand until the grape leaves appear. By this time they are out in large numbers. They feed for some time before egg laying is begun. The eggs are laid on the under surface of the leaf beneath the

epidermis. Egg laying probably extends over two months. There is no larvae stage, but the eggs hatch into a whitish nymph with reddish eyes. These nymphs feed by sucking juices from the leaves of the grape as in the adult stage. During the early nymph stage the hoppers run rapidly over the surface of the leaf, but do not jump or fly. Prof. Slingerland found that from thirty to thirty-five days were required in the summer for the development of the adult and that under the conditions in the Chautauqua Grape Belt, but one full brood and a partial second brood is produced each year. The largest number of nymphs were found in 1910 from July 15 to 25. In late summer all stages will be found upon the leaves. On September 21, 1910, adults were found drifting with the wind to winter quarters.

Remedial Measures: The Leaf Hopper is combated with difficulty, and various ingenious devices have been used at different times. Torches have been carried through the vineyards at night, the vines being disturbed at the same time. The hoppers fly into the flames and are destroyed. Trash should be raked and burned as a preventative.

Prof. Slingerland used a device in his experiments in New York which consisted of a light wooden frame seven or eight feet long, by four feet high. To the base piece of the frame, which should be a foot or more above the ground, are fastened several stiff wires bent in the shape of a hayrake tooth. To this frame and these wires are attached a covering of oilcloth which is coated with a sticky preparation composed of one quart of melted resin and one pint of castor oil. This device was drawn through the vineyard early in the season before the hibernating adult had begun ovipositing.

Extensive tests have since been run in which it has been found practicable to destroy the young wingless hoppers or nymphs with a whale oil soap solution; the soap being used at the rate of one pound to ten gallons of water. During the summer of 1910 Prof. Fred Johnson, of the Bureau of Entomology, has used with a great deal of success a solution of tobacco extract or sheep dip. The extract used was put up by "The Kentucky Tobacco Product Co.," of Louisville, Ky. The dilutions varied, but one to one hundred was usual, one gallon of the extract to one hundred gallons of water applied with a movable Spray Motor Nozzle. The spray must be directed against the underside of the leaf so the nozzles are turned upward and the man doing the spraying works slowly forward, taking pains to hit all of the leaves. The results of this spraying are shown in Fig. 33. Those unsprayed are badly injured while those sprayed show but little injury. The time of application of this spray varies with the development of the nymphs, but it should be applied before the nymphs begin to get wings. The date varies from the 10th to the 25th of July at North East,

Rose Chafer or Rose Bug (*Macrodactylus subspinosus*): This insect and its work scarcely needs any description. It usually appears about the time grapes are in bloom. It appears in enormous numbers and feeds upon the blossoms and leaves, eating into the buds of the fruit clusters and destroying them. They are often so abundant as to do great damage in a grape vineyard. The insect lives under the ground in the larvae stage, feeding upon the roots of the grasses and other plants. They breed largely in light sandy meadow land and other places where there is more or less growth of grass and weeds.

Description and Life History: This insect is a beetle about a third of an inch long, with light brown wing covers and long crooked legs. The beetles deposit their eggs in clusters of from twenty-two to twenty-four beneath the ground. The larvae hatch and feed underground upon the roots of plants during the summer, being nearly mature by fall. They burrow below frost during the winter, ascending to the surface in the spring where they enter the pupa stage. Here they remain ten to thirty days before coming out as adults to attack the grape and other plants.

Remedial Measures: The beetle may be poisoned; but they seem to come again in endless numbers. Heavy applications of arsenate of lead and Bordeaux mixture may act as a protection. Five or six pounds of arsenate of lead may be used if plenty of lime is added. Hand picking may be successful if only a few vines are infested, but it is not practicable in a commercial way, because of the great numbers. Their breeding grounds should be plowed. Bagging the young fruit clusters may afford protection.

During the season of 1910, Prof. Fred Johnson, of the Bureau of Entomology, has been using a gallon of molasses to fifty gallons of the arsenate of lead and Bordeaux mixture spray with good results. The formula used was 5-3-3-1-50, in which five pounds of arsenate of lead and one gallon of molasses was used with the 3-3-50 Bordeaux formula.

Grape Curculio (*Craponius inaequalis*): This is one of the snout beetles, belonging to the same family as the Plum Curculio. The beetles cut small characteristic feeding holes in the leaf. The parent beetle deposits her eggs in the little cavities which she eats into the grape. The resulting larvae feed upon the pulp and seeds protruding on injured fruit similar to that of the Berry Moth larvae. The berries show a purplish coloration at the point punctured by the egg laying.

Life History: The insect passes the winter in the adult or beetle stage under trash in or near the vineyard. About the time when the grapes are in bloom the beetles come from their hibernating places and feed upon the leaves for three or four weeks until the

berries reach about one-fourth size, or large enough to receive the eggs. The larvae, after feeding upon the pulp, drop to the ground and form a cell beneath the surface where it pupates. The adult beetle emerges in about eighteen to nineteen days and feeds upon leaves until fall. The beetle is blackish in color, with gray hairs at first, afterwards becoming the normal brown.

Remedial Measures: This beetle is easily controlled by the spraying given the Root Worm, and the Berry Moth. It is easily poisoned by arsenicals while it is feeding upon the grape leaf.

FUNGUS DISEASES

Fully as important as the insect pests are the fungus diseases. These diseases are now controlled very successfully by fungicides, the preparation of which has already been given.

The fungus parasites of the grape came originally from the native wild vines; but as the vines have been improved the disease resistance has been more or less overlooked, hence, the improved varieties are very susceptible to fungus troubles.

It is stated by Prof. C. L. Shear, of the Bureau of Plant Industry, that the amount of loss from fungus diseases of the grape in the eastern part of the United States during 1906 was estimated at from fifteen to twenty per cent. of the entire crop. In some localities it has reached forty to fifty per cent., and in some particular vineyards where there was promise of a crop of four or five tons per acre the loss was total, while in one favored region the loss was not over five per cent.

The weather conditions are very closely related to the injury from fungus diseases as described under climate early in this bulletin. The fungus disease most common and most destructive are Black Rot, Downy Mildew, Powdery Mildew, Anthracnose and Ripe Rot, named in order of their respective injury.

Black Rot (*Guignardia bidwellii*): This disease is now quite generally known to the grape growers in the eastern part of the United States. It has been a very destructive pest in the North East region, but is now almost completely under control. The percentage of injury has been very slight for several years, so much so that some growers have deemed it safe to drop the numbers of spray applications from five or six to one during the season. This practice should be discouraged, because it is giving an opportunity for the fungus to again get a foot-hold.

Description: The first appearance is usually upon the leaves and young shoots where reddish brown spots are formed. The fungus is seldom noticed until it affects the fruit. The mycelium of the fungus is not heavy, but is found under epidermal cells of the host.

Small black pustules in which the summer spores are produced are formed upon the surface of the fruit. The disease is often not noticed until the whole berry is infected and begins to shrivel. These shriveled berries do not drop from the vines, but produce another stage known as the winter stage or resting stage. In this stage, resting spores are produced which live through the winter and infect the growing tissues of the plant on the following spring. To help in the prevention of this disease, all diseased fruit and leaves should be taken from the vineyard and burned. The remaining litter may be plowed under early in the spring.

Remedies: Bordeaux mixture, prepared as described under spraying, is the most effective remedy for this disease. Prof. C. L. Shear, of the Bureau of Plant Industry, advocates five or six applications, beginning when the shoots are eight inches to one foot long and continuing every two or three weeks. This practice gave ordinarily as good results as where one or two applications were made earlier.

Copper acetate, one pound to fifty gallons of water, has been found to be the best non-staining preparation. It is used for the last application to avoid the staining of the fruit so late in the season that it will be noticeable when marketed. All prunings should be taken from the vineyard and leaves plowed under.

Downy Mildew (*Plasmopara viticola*): This is a fungus of American origin, confined mostly to the Eastern states. It is especially prevalent under Pennsylvania conditions. The fungus attacks practically all of the young growing portions of the vine, leaves, shoots and berries. It is largely confined to the leaves where it produces discolored spots which prevent or inhibit the normal activities of the leaf. It is most abundant through August and September.

Description: Irregular or indefinite spots of a yellowish color appear upon the upper surface of the leaf. Later in the season these spots may turn brownish and become more visible upon the under surface. If the fungus is very severe, the leaf dries and falls prematurely, and the twigs, showing depressed scars of a dark color, are produced. The fungus upon the fruit produces what is sometimes called gray rot when the berry is two-thirds grown. It occurs most generally upon the young fruit.

Remedies: This fungus is easily controlled by spraying with Bordeaux mixture. When spraying is done for Black Rot no additional spraying will be needed for this fungus.

Powdery Mildew (*Uncinula necator*): The fungus is a native of America. It is often found in the same vineyard with Downy Mildew. The mycelium of the Powdery Mildew is produced upon both surfaces of the leaf. Vinifera varieties are very susceptible.

Description: The mycelium of the fungus is very superficial in its habits of growth; that is the mycelium does not enter the tissues

of the plant to destroy them but grows upon the surface, obtaining its nutrition through sucker-like appendages which penetrate the cell walls of the surface layer of the leaf. The spores are produced in short chains upon branches arising from the white filamentous growth upon the surface of the leaf. Those whitish spores are formed in immense numbers and shed upon the surface of the leaf, giving it a grayish mealy appearance, specked with brown. Powdery mildew is more prevalent during dry, hot weather, differing from the other grape diseases in this respect.

Remedies: Under Pennsylvania conditions it should be treated with Bordeaux mixture as outlined under Black Rot.

Anthracnose (*Sphaceloma ampelinum*): This disease has been quite injurious in Pennsylvania of late years. It is known commonly as the "birds-eye" disease, and has been known in European vineyards for many years.

Description: The disease occurs upon the berries, shoots, and leaves, but is far more common upon shoots and berries. Small ashen brown spots appear, and as these enlarge in a more or less regular manner, a paler central portion is surrounded by rings of brown with a band of red and reddish purple. The spots become depressed and sometimes fall out of the fruit. Small spots may unite to form one large and irregular spot. The spots do not become soft, but are hard and wrinkled. The berries sometimes continue to grow, rupturing the grape and often exposing the seed.

On the leaves it appears as small brown irregular spots, darker on the margin. The spots upon the canes are much like those upon the leaf but somewhat elongated.

Remedies: This disease is not easily controlled as the other fungus diseases of the grape. Bordeaux mixture is not sufficient; all diseased canes should be cut out, if possible, and burned. If the disease becomes very severe, a treatment may be used, which has been found successful in Europe. This consists of the application of the following mixture:

Sulphate of iron (copperas),	100 pounds.
Sulphuric acid—commercial,	1 quart.
Hot water,	26 gallons.

First pour the acid upon the copperas and then add the water. This mixture is exceedingly caustic and should not be allowed to strike the clothing or the skin. It cannot, for this latter reason, be applied with the ordinary spray outfit. A swab, made by attaching a bundle of rags to a stick, may be used in applying the mixture. All proportions of the vine should be thoroughly covered with this preparation just before the buds begin to swell in the spring.

Ripe Rot (*Glomerella rufomaculans*): This disease is sometimes known as bitter rot, because of the taste given to the berries attacked by it.

Description: The berries of the grape turn reddish brown as they are ripening. The fruit develops little black pustules much like those of the Black Rot, but not so numerous. Differing from the the Black Rot, the berry remains a brown color, shrivels up and drops to the ground.

Remedies: The disease will be held in check by the same treatment recommended for Black Rot, if special care is taken to have the latter application thorough.

Necrosis: This is a disease described by Prof. Donald Reddick, of the Cornell Experiment Station. The disease was studied mainly in the grape growing region of western and central New York. In the Chautauqua Grape Belt it is naturally the Concord which is mostly affected. A young vineyard of fourteen acres was inspected by Prof. D. Reddick, in 1907, in which at a fair estimate four thousand to five thousand vines were dead or dying from this disease.

Symptoms: (1) A trimmed and tied vine which has failed to put out shoots. Such a vine usually splits open longitudinally during hot weather. (2) A vine that has sent forth shoots, then later dying after a few weeks. (3) Vines on which all or part of the shoots and leaves exhibit a dwarfing; introduces short leaves, very small and often crimped about the margin. Apparently healthy vines with the fruit shriveling away in the middle of or late in the summer. The presence of fleshy or corky excretions on the stem and arms in the summer, turning reddish brown in the autumn. The presence of black pustules or fruiting bodies on the dead spurs. Reddish brown spots of one-eighth of an inch in diameter on the green shoots. The disease has not been studied in all of its details. It is one of the important causes for the growing popularity of the Chautauqua Improved System of pruning.

Remedies: The diseased vines should be cut back, removing all traces of the fungus. If this is done carefully the resulting growth will be free from disease. Cutting the vines back should be done by tools which are never used upon healthy vines. There is no difficulty to detect this fungus in the trunk when sawed off; but it must be remembered that the fungus may have traveled farther than the brownish area. The stub should be coated with lead and oil, after the cut is made.

BUSINESS MANAGEMENT

AT THE PLANTATION

The management of a large vineyard requires a man of skill, originality, and attention to details. Much of the success of the vineyard depends upon such a man. It is necessary to study into the details of the production and marketing. Lack of proper cultivation may be the cause of small yields. A different kind of fertilizer may be needed. Perhaps an insect or fungus disease is making inroads upon the vineyard and destroying the margin of profit.

The vineyard manager must be a man who can successfully employ and direct labor. Much labor of various kinds is necessary. He must believe in his business and be willing to take risks.

The farm, to be a successful vineyard plantation, must be chosen with the points in mind that are brought out under the heading of Location. The soil must be moderately fertile and well drained, either naturally or artificially. The haul to the shipping station must be as short as possible. The farm must have points that mark it for development.

Grape growing requires a fair outlay of capital. The vineyard will cost about \$100.00 per acre, to bring it into bearing. This includes the plants, setting, cultivating, trellising, pruning and care. This, added to rather high cost of land, makes the vineyard in bearing cost from \$300.00 to \$500.00 per acre in the North East district. Each year brings the operations of pruning, tying, plowing, horse-hoeing, cultivating, spraying, fertilizing, picking and handling of the crop. It has been estimated that these operations, including the interest of the money invested, cost eight cents per basket, or \$80.00 per acre, annually for a 1,000 basket yield. In the year 1907 the average price received by growers for the entire season was twenty cents per 8 pound basket. In 1908 the average price per 8 pound basket was fifteen cents. In 1909 it was eleven cents per 8 pound basket. In 1910 the crop averaged the growers nineteen cents per 8 pound basket. This makes an average for the four years of sixteen and one-fourth cents per eight pound basket, or \$162.50 per acre for a 1,000 basket crop.

Machinery is quite usually housed in this region. This is a matter that is often thought of little consequence, and yet it is one of the avenues through which the margin of profits leak away on many farms. Machinery needs housing from the sun and rain. It is not a great expense to provide a shed into which the tools may be run

when not in use. During the winter season, if the tool shed is built tightly, repairs may be made and the tools cleaned and pointed for the coming busy season.

The vineyard manager or owner should inspect his vineyard frequently. Cultivation should follow every rain as soon as the soil is dry enough; the vineyard should be closely watched for insect and fungus pests. One or two days may mean many dollars loss in the latter case if remedial measures are not taken in time.

The problem in getting efficient labor is a pressing one in many places. Day labor costs from \$1.50 to \$1.75, and labor by the month costs about \$35.00. The grape industry requires a great deal of labor at certain seasons of the year. To meet this demand a large number of girls and women from sections near the grape belt come in for the six weeks picking season and do piece work, receiving $1\frac{1}{4}$ to $1\frac{1}{2}$ cents per 8 pound basket for picking and packing. These laborers are given rooms and necessary equipment for preparing their own meals, or they are given good board at a moderate cost. Good wages prevail and the laborers are generally quite well satisfied and plentiful in the district.

Tools and equipments on the vineyard plantation should be of the best types and well cared for. The necessary tools, are a three or four gang plow, a disc harrow, the Peabody cultivator, the horsehoe and some standard type of a sprayer, such as the Brown, the Pierce-loop or the gasoline engine sprayer which is manufactured by the Friend people. The fixed nozzles of the Cyclone type will give efficient service.

For handling the crops, spring wagons are used, as is shown in the illustration (Fig. 36). Even the heavy wagon for hauling the finished product must have a good set of springs. A good serviceable packing house with all possible conveniences is of course needed. Good horses are also necessary in the successful equipment of the vineyard farm. The team is used in nearly every operation and has much to do with the outcome of the industry.

PREPARATION FOR MARKET AND MARKETING

The Popular Size of Package: The eight pound grape basket is the most popular size of package for the Concord grape. It meets with approval, because it contains the right amount of fruit for the ordinary size of family and may be carried home from market conveniently. It is neat and trim in appearance, packs well in a car for shipping and loads easily upon a wagon. It is loaded upon a wagon or car by placing two baskets side by side and two horizontally upon the top with the handles of the bottom two projecting up through

the space between the baskets. In this way very little space is wasted and the load carries well. This basket is covered with a wood cover held down with small angled staples.

For the earlier grapes the four pound or pony basket is a popular type of package. The earlier grapes are usually much higher in price than those later in the season, hence the importance of packing in a small package, which may be sold more readily. Many people will buy the pony basket and pay as much for it in the earlier part of the grape season as they will pay for the eight pound basket later on. It is not so much the size of the package as the size of the price which draws the buyers. This is a rule that holds true to all kinds of fruit. Pack fruit in a small and attractive package if you wish them to find a ready market at profitable figures.

Grapes, which are unfit for the table trade because of imperfections of various natures, are picked in the twenty pound trays. These grapes are injured by insects, droughts, lack of cultivation, etc., until they must be utilized for wine or grape juice. However, the tray is little used except locally.

Picking and Packing in the Vineyard: Grapes are usually packed in the vineyard at the time of picking. The pickers carry a small pair of scissors which are used to clip the clusters of fruit from the vines. The packages or baskets are supported by a stand, as shown in the illustration (Fig. 37), holding three eight pound baskets at a convenient height. The clusters as they are clipped from the vines are placed in the basket, usually in two layers, the basket being well rounded up under the handle. As the baskets are filled, they are placed in the space between every other row to allow the grape wagon access to the vineyard. Baskets are distributed from the grape wagons, ahead of the pickers, so no extra steps need to be taken. Two pickers work together, placing their filled baskets between the rows that they are picking, as shown in the illustration (Fig. 38.) Pickers sometimes pick one hundred and twenty baskets in a day, but the crop must be very good and the picker active to accomplish this.

Collecting and Hauling to the Packing House: The collecting of the baskets from the vineyard is done with the grape wagon, as shown in the illustration (Fig. 39). This is a low platform wagon just wide enough to go through the vineyard easily. The platform is set upon springs and has racks, as shown in the illustration (Fig. 36), to hold the baskets in place while they are being hauled over rough ground to the packing house. The wagon is driven through the space which contains no baskets, and a man upon the ground raises the baskets over the top of the trellis, as shown in the illustration (Fig. 36). Usually two men work upon the ground loading from

opposite sides of the wagon. The third illustration (Fig. 40) shows the boards with cleats attached upon which the baskets are placed. This is necessary to prevent crushing the grapes in the upper clusters. The baskets are unloaded upon a platform at the packing house which should be as high as the wagon platform. Many use a low wheeled truck to handle the baskets in the packing house. The baskets are corded up in the packing house by one of the two methods shown in the illustrations (Figs. 44 and 45), either by a board being placed on top of the handles or by setting the basket in the second tier, on a slant, one end resting upon the handles of the baskets underneath and the other end resting upon the ends of the baskets underneath. The next is then set level one end resting upon the handle of the basket underneath and the other end on the upper angle of the basket beneath.

Honest and Attractive Packing: The packing house is where the finishing touches are put on the package. To be convenient, the packing house must be large enough to hold a large supply of empty baskets before the season begins. Long before the grapes are ready to be picked the packing houses are busy places. The handles must be nailed on after the baskets are brought from town. The empty basket with a handle takes more space than without a handle.

The label of the grape shipper, who is to handle the output of the vineyard, must be pasted upon the covers. Everything must be made ready for the busy season. There must be space in which to store large quantities of grapes. Many packing houses have conveniences for the pickers, some of them being fitted up with kitchen outfits where the girl pickers may prepare their meals. Rooms are provided for the pickers in these packing houses where the girls spend their spare moments during the picking season which lasts about five or six weeks.

Settling: The grapes are allowed to settle before the covers are put on. This takes a day at least, sometimes longer. The settling brings the grapes nearly on the level with the top of the basket, allowing the cover to be nailed on without jamming the fruit badly. The covers are nailed on as shown in the illustration (Fig. 46), and the baskets are loaded upon the wagon for the shipping station.

Uniformity and Cleanliness: The packing of grapes is done with much care in the North East district. Uniform clusters are used and berries not coming up to the standard are clipped out. The bunches are placed in the basket with as little handling as possible. The bloom adds much to the appearance of the Concord grape. Uniformly large and perfect berries as well as clusters of large and uniform size are wanted by the growers. The market value of the package of grapes depends much upon the cleanliness of the pack.

Berries must not be crushed nor brushed unnecessarily. The outside of the package must not be soiled either by the fingers or by rough handling.

Hauling and Loading: Platform wagons are used for hauling the finished product to the loading station. (Fig. 47). These wagons and racks are strongly built to carry a very heavy load. Heavy draft horses are used where long hauls are made, however, no very long hauls are necessary in this district because of the excellent transportation facilities, and the narrowness of the district. The length of the haul influences the price of the land for growing grapes; land being obtainable much more reasonably some distance from the loading station.

Loading and Icing: Many cars are loaded daily at most of the loading stations. This makes it necessary to keep accurate records also to employ men who are skilled in loading fruit cars. From twenty to eighty cars are shipped daily during the busy season. Many of these go westward at the present time.

The refrigerator cars are used, being iced as they are loaded with the fruit, at the North East shipping station. This is a great advantage in that it keeps the fruit cool from the time it enters the car until it is unloaded at its destination. The reader, by reference to the illustration (Fig. 48), may see the equipment used for icing the cars, which consists of a sliding board on wheels and a pulley arrangement handled by a horse. When the block of ice reaches the opening in the top of the car, the tongs are opened much as a hay fork and the ice drops into place.

The North East Plan of Marketing: The majority of the growers at North East belong to the Horticultural Society of the region. This society meets regularly and discusses methods of interest to all. The society, as a rule, meets to decide when picking shall be started in the district according to markets. The marketing is not done on the co-operative plan, the crop being handled by several buyers, who are in many cases large growers themselves. These buyers maintain a representative in every large city in which the buyer is doing business. The representatives look after the selling in these cities, handling the grapes at that end, or more strictly speaking, watch the markets and take orders. The growers deliver the grapes at the station packed and covered with the label of the buyer upon each basket. The grapes are weighed and loaded directly into the refrigerator cars, credit being given the grower upon the books. The buyer deducts one-half cent upon each eight pound basket from the selling price for his commission. From this commission he pays freight, telegram bills and salaries of clerks and representatives in the home office and in various selling points.

Co-operative Systems of Marketing: The co-operative system of marketing has reached a very high state of development in the West and merits some consideration in this connection. In business we recognize the necessity of dividing the activities into the buying end and the selling end. No one man is capable of mastering completely both phases of the enterprise. For this reason our railroads are divided into the passenger service, freight service, express service, etc., each directed by a man especially trained for his work. In fruit growing, where so much depends upon the turning of a perishable article economically and quickly into cash, there is the greater need for skill.

The ordinary fruit grower cannot take the time to keep in touch with the markets as closely as is necessary. Or, he may have the embarrassment of having to sell for less than the value of his crop because some grower has sold under value near him. This grower sold because he did not know the markets, thus spoiling the chances of others in his district.

The important growers in a district may form a district association by banding themselves together under a contract to sell all of their fruit through the co-operative association. If the more important growers are in favor of the association, it may be safely launched. The smaller growers will come in later.

The manager of the association should have charge of the hiring of packers and selling of the fruit. The selling is usually done through a representative in other cities or by telegrams. The manager must insist upon his rules for uniform packing and leave sufficient men to enforce his rules. He must be able to guarantee his fruit to be the same at the bottom as upon the top and the same in the middle as in the bottom.

To draw up the constitution and by-laws of such a district association, a board of directors are elected by the members of the association to serve for a certain time stated in the by-laws. The directors frame the contract to be signed by each grower in the association, stating that he will sell all his fruit through the co-operative association. Usually these contracts must be signed, before a certain date or the member is barred from the association.

One way in which the association shows its worth is in buying of packages, spraying materials, fertilizer and machinery by the wholesale. In this way the price is much reduced to each grower. Further, the association benefits the grower by furnishing him with information. A file of agricultural experiment station bulletins are kept where the farmers may have access to them. All the important papers and magazines on horticultural subjects are kept at hand. The grower may find out how to mix a certain spray by referring to this library or by asking someone at the association office.

Each member is paid for the grade of fruit he furnishes. So he has the incentive to produce the best. He is paid the price that his fruit brings in the markets, less a certain amount for freight, telegrams and the payment of labor for the association.

The several smaller district associations combine through their several managers into a grand association. The managers meet in a body and decide upon a certain policy of marketing, which is to be followed by all. This helps the distribution of the fruit. One city is not overcrowded with fruit one day while another is bare. A general scheme is followed out in this way, supplying the demand and yet keeping the appetite keen and the price at the top notch.

SUMMARY

The problems encountered in starting and seccessfully carrying on the grape industry may be grouped under the Choice of Location, Production, and Business Management. The former is especially important to the prospective "grape grower" who has his farm to purchase upon which to build up a successful enterprise. The latter two parts of this work try to make clear in some detail the many operations in caring for the vineyard from the start and of placing upon the market the finished product in a business like manner.

A general idea is given of the methods of field work and the character of the region comprised in this survey; the importance of the grape as a money crop to individuals and to a district; the new avenues for the use of grapes and their effect upon the development of the industry; a brief and fragmentary history of the grape in this country showing the reason for the cultivation of the native grapes.

The factors influencing the choice of a location have been emphasized under soils, climate and availability to the markets. Some of the reasons why this district has become an important grape growing center have been traced as a guide in choosing locations where the grape will produce well.

The details of production have been traced, beginning with the preparation of the soil for setting of the vines, propagation, planting distance, number of vines per acre, yields and description of varieties for commercial planting. Tillage, fertilization, and cover crops were discussed, including extent and depth of cultivation, formulas and fertilizer requirements of different soils. Different

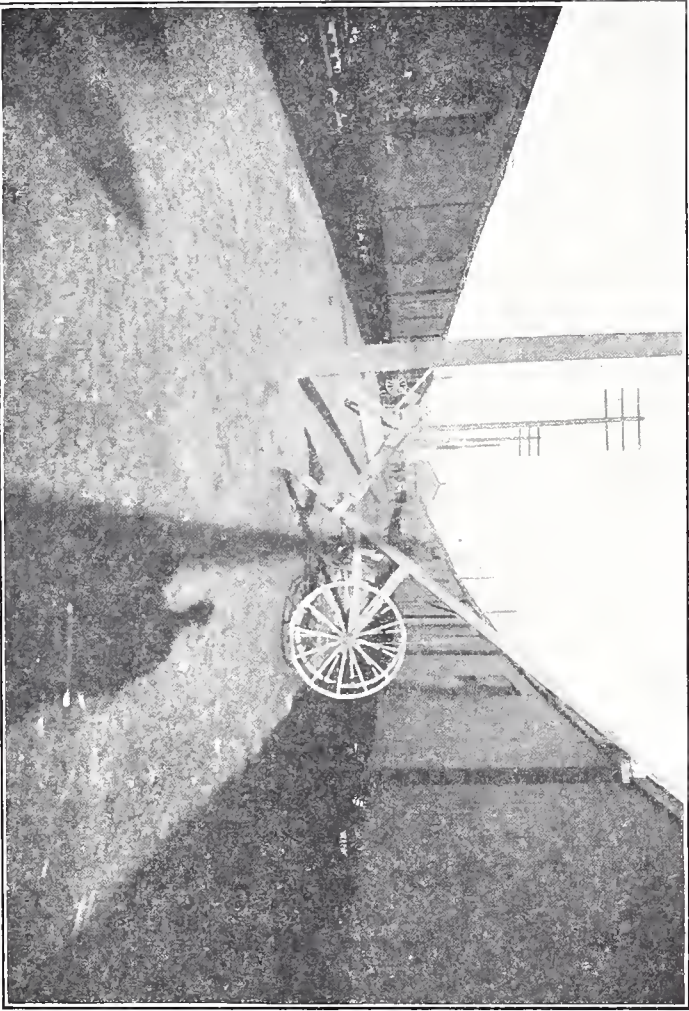


Fig. 49. The implement used for icing the cars.

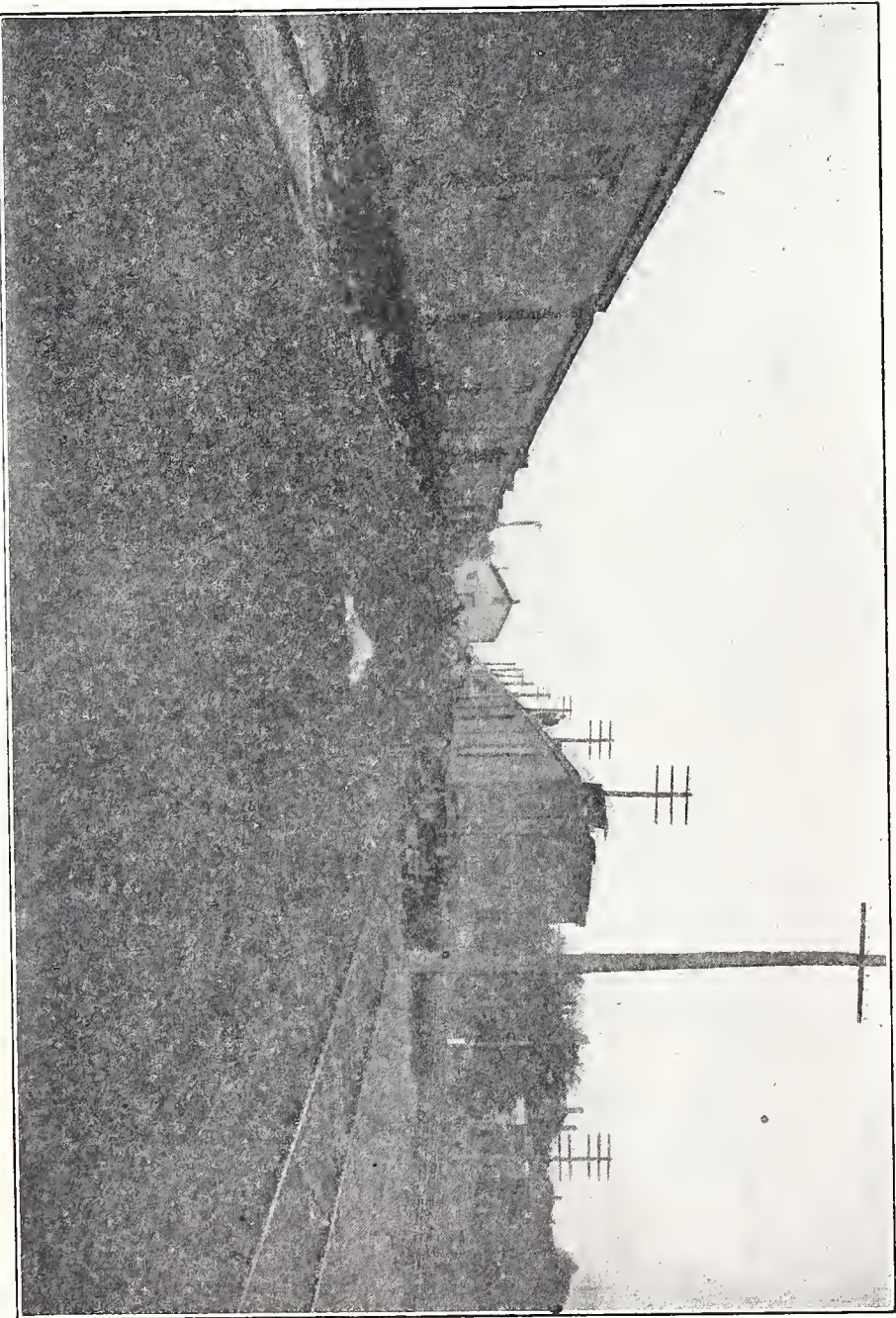


Fig. 50. Busy days of loading and shipping grapes.



Fig. 51. Another shipping yard with the grape products plant in the background.

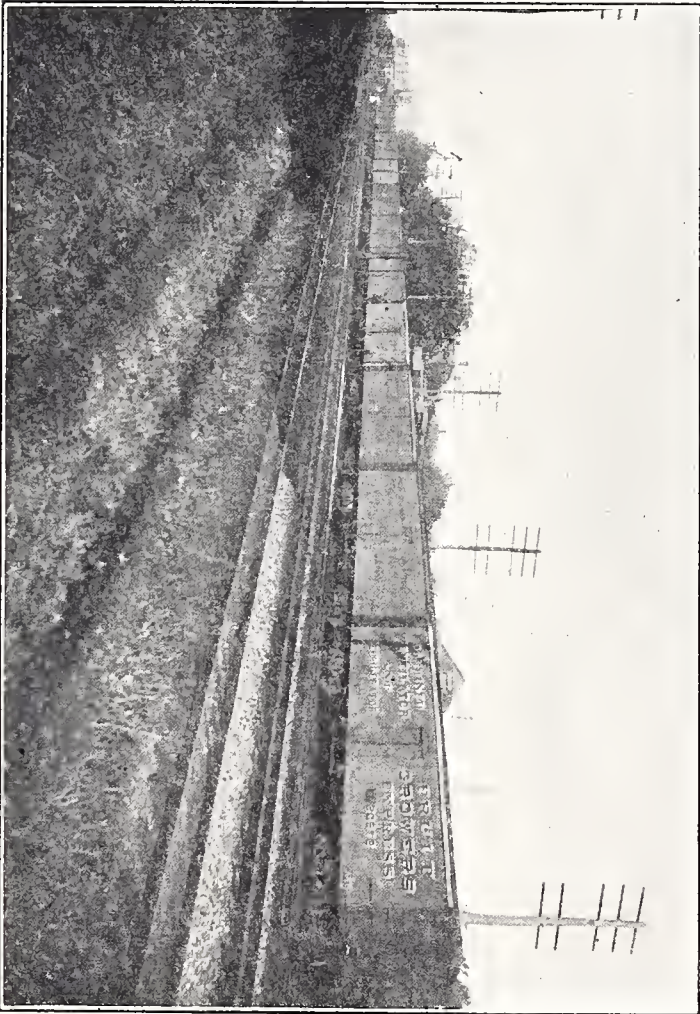


Fig. 52. A loaded "Grape Train" leaving for the West.

plants used for cover crops were mentioned with advantages and disadvantages. Construction of the trellis with various systems of training, and the details of pruning, bagging and ringing. Preparation and application of insecticides and fungicides with the description of the important insects and fungus pests apt to be encountered.

The management of the plantation is considered in its several phases. The preparation of the grape crop for market and the use of the popular size in package, with attention to attractiveness and cleanliness. Loading and icing of cars for shipment is discussed. Different plans of marketing the grape product are explained.

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